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**CHEMICAL AND PHYSICAL QUALITY OF
WATER RESOURCES IN CONNECTICUT**

1955 - 1958

(Progress Report)

By

F. H. Pauszek

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Connecticut Water Resources Bulletin No. 1

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PREFACE

A program to appraise the chemical and physical quality of surface and ground waters in Connecticut was started in 1955 by the U. S. Geological Survey in cooperation with the State Water Resources Commission. The objective of the program is to provide information for those concerned with the use of water insofar as it is affected by solutes, temperature and suspended sediment. This is the first in a series of planned reports on the chemical and physical quality of water resources in Connecticut. It contains results of the investigation through 1958.

The program could not have been started and continued without the interest and support of William S. Wise, Director, Connecticut Water Resources Commission. Others were helpful in furnishing information needed for the preparation of this report. Records of discharge were furnished by B. L. Bigwood, District Engineer, Surface Water Branch, Hartford, Connecticut; geologic information and temperature data were furnished by R. V. Cushman, Geologist-in-Charge, Ground Water Branch, Middletown, Connecticut; chemical analyses were made by personnel of the Quality of Water Branch, Albany, New York. The program is under the general direction of S. K. Love, Chief, and the immediate supervision of F. H. Pauszek, District Chemist, Quality of Water Branch in Washington, D. C. and Albany, New York respectively. All of the branches mentioned are organizational units of the U. S. Geological Survey.

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CHEMICAL AND PHYSICAL QUALITY OF WATER RESOURCES IN CONNECTICUT

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ABSTRACT

The chemical and physical quality of water resources in Connecticut ranges from good to poor reflecting the influence of diverse geology, streamflow, and, in some areas, pollution.

In the upper Housatonic River basin in the western part of the State, streams draining the limestone areas have a chemical composition consisting principally of calcium and bicarbonate, contain concentrations of dissolved solids as high as 216 ppm (parts per million), and are moderately hard. In the lower part of the basin, streams draining crystalline rock are low in dissolved solids, and are soft. Stream pollution is present in some sections of the basin, especially in the Naugatuck River, and unusual changes in the chemical quality of the water are attributed to it.

Ground waters in the upper basin also show wide differences in the chemical quality depending on whether the water-bearing formation is crystalline rock or dolomitic limestone. In the Naugatuck River valley in and near Waterbury the chemical quality of water from some shallow sand and gravel aquifers is lowered by infiltration of water of poorer quality from the river. Other aquifers in the same area appear to be unaffected and contain water of better quality.

The Connecticut River and its tributaries drain an area of sandstone, shale and crystalline rock overlain by unconsolidated deposits of sand, gravel and till. Mineral matter from these deposits is moderately soluble. This is reflected in the dissolved-solids content of the major streams - 40 to 90 ppm; about twice as high in some smaller streams. Although the increase in mineral content due to inflow of industrial wastes is undetermined, the mineral content of the major rivers does not appear excessive. Higher streamflow in the major rivers has a moderating influence on the chemical quality.

Ground water is obtained from bedrock and unconsolidated deposits, the latter, with the exception of till, is more productive. Chemical quality of water from sand and gravel ranges widely. The concentrations of dissolved solids in water from these deposits are about 300 ppm or less and the waters are soft. Generally the chemical quality of water from sandstone is similar to that obtained from sand and gravel deposits.

The Quinnipiac River at Wallingford contained dissolved solids ranging from 103 to 174 ppm. The concentrations were usually higher than those in other major rivers in the central part of the state. The chemical quality of ground water has not been determined.

Generally, the chemical quality of surface waters in the Thames River basin was as good or better than that of surface waters in other basins throughout the state. Some surface waters in the basin contained concentrations of dissolved solids as low as 32 ppm and had a hardness as low as 10 ppm. Most streams contain domestic and industrial wastes in varying quantities but the direct contribution to the mineral content of the water is not known. At present no data have been obtained on the chemical quality of ground water in the basin.

Temperatures of surface waters in Connecticut follow a seasonal pattern. They decrease erratically late in October, hover near freezing during the winter months, and gradually rise in April. Ninety five percent of the time water temperatures in major streams equalled or were less than 80 degrees Fahrenheit.

A sediment station has been operated on the Scantic River at Broad Brook since 1952. About 50 percent of the time, the sediment discharge rate is less than 10 tons per day. With rising stage, sediment discharge increases rapidly for short periods. During the hurricane floods of 1955, the suspended sediment load for August 1955 was 12,115 tons of which 70 percent (10,890 tons) passed the Broad Brook station during a two-day period.

The chemical quality of most surface and ground waters in the state is satisfactory for multiple uses but not necessarily satisfactory for all uses. Iron is present in excessive concentrations in some surface and ground waters and could be a problem. Fortunately, with suitable treatment the chemical quality of most waters can be improved if necessary.

INTRODUCTION

Water Quality and Environment

Quality of water is the end product of the interaction of water and its environment. More specifically, "quality of water" as used in this report refers to the quantity and kind of material in solution and suspension (excluding living organisms), the resulting chemical and physical effects, and temperature. Water is the aggressive agent and the environment is the aggregate of all external conditions and influences. Initially, atmospheric water is similar in quality to that of distilled water. However, this condition is soon altered by substances in the atmosphere. Gases and minute quantities of minerals are being dissolved and even solid particles may be in suspension. Reaching the earth and flowing over the land surface or underground, water dissolves mineral matter and industrial and domestic wastes with which it comes into contact. In addition to its solvent action, surface water is capable of eroding and transporting soil particles. Being an excellent heat-exchange medium, the temperature of water changes with its environment. High streamflow usually will reduce the concentrations of solutes in surface waters by dilution. Inflow of ground water adds to the mineral content especially during periods of low streamflow. Obviously the environment plays an important role in fashioning the quality of water.

Environmental Factors

What are some of the environmental factors in Connecticut that affect the chemical quality of water? Two well known major factors are precipitation and geology. In these two fields extensive studies have been made and long periods of record are available.

Pre-
cipi-
ta-
tion

Connecticut, as do most states in the Northeast, receives an ample supply of precipitation throughout the year. The total precipitation usually ranges from 45 to 50 inches but as much as 75 inches has also been recorded. Areally, variations in precipitation throughout the State are about the same. The extremes may range from a low of 30 to 35 inches to a high of 60 to 65 inches. The average and monthly precipitation records compiled by the U. S. Weather Bureau for periods as long as 82 years are shown in table 1.

Although the amount of precipitation is rather uniformly distributed throughout the year, the amount of surface-water runoff varies seasonally. During the winter months, snow may remain on the ground and may contribute substantially to the spring runoff as it melts. During the summer months, precipitation is also generally ample. However, this period represents the growing season. Air and water temperatures are higher. Water losses occur through evaporation, transpiration and retention by vegetation. As a result, runoff is reduced--for example, Quinebaug River at Jewett City (fig. 1). During the period June through October runoff is only about 28 percent of the total rainfall (using rainfall data obtained at Storrs).

These variations in streamflow lead to fluctuations in the quality of surface waters as will be shown later. During high streamflow, dilution reduces the concentration (weight per unit volume) of dissolved solids; cooler water will lower the water temperature; and the rate of sediment discharge (tons per day) may rise. During low flow, however, the concentrations of solutes are greater because dilution is less effective, and inflow of more mineralized water from ground storage adds to the solute content. Water temperatures are affected more by air temperatures; especially shallow streams. As stream velocities decrease heavier suspended sediment particles deposit and sediment discharges are reduced.

Geology

Bedrock in Connecticut consists chiefly of three distinct rock groups: Pre-Triassic crystalline rocks in the eastern and western parts of the State, Triassic sedimentary rocks in the central part, and a narrow belt of Paleozoic limestone (marble), also in the western part of the State (fig. 2).

Table 1. - AVERAGE MONTHLY AND ANNUAL RAINFALL, IN INCHES, AT SELECTED STATIONS IN CONNECTICUT*

Month	Station and Section of State			
	Norfolk (Northwestern)	Hartford (Central)	Storrs (Eastern)	New Haven (Coastal)
January	3.87	3.15	3.67	3.89
February	3.51	2.57	3.37	3.30
March	4.16	3.81	4.12	4.12
April	4.21	3.56	3.56	3.89
May	4.33	3.66	3.50	3.87
June	4.85	3.62	3.17	3.81
July	4.16	3.56	4.22	3.66
August	4.20	3.54	4.16	4.11
September	4.16	3.44	4.07	3.46
October	3.40	2.80	3.58	3.00
November	4.59	3.48	3.47	3.94
December	4.04	3.29	3.65	3.94
Annual	49.48	40.48	44.54	44.99

(U. S. Weather Bureau)

*Years of Rainfall Records:

Norfolk.....40

Hartford.....50

Storrs.....64

New Haven....82

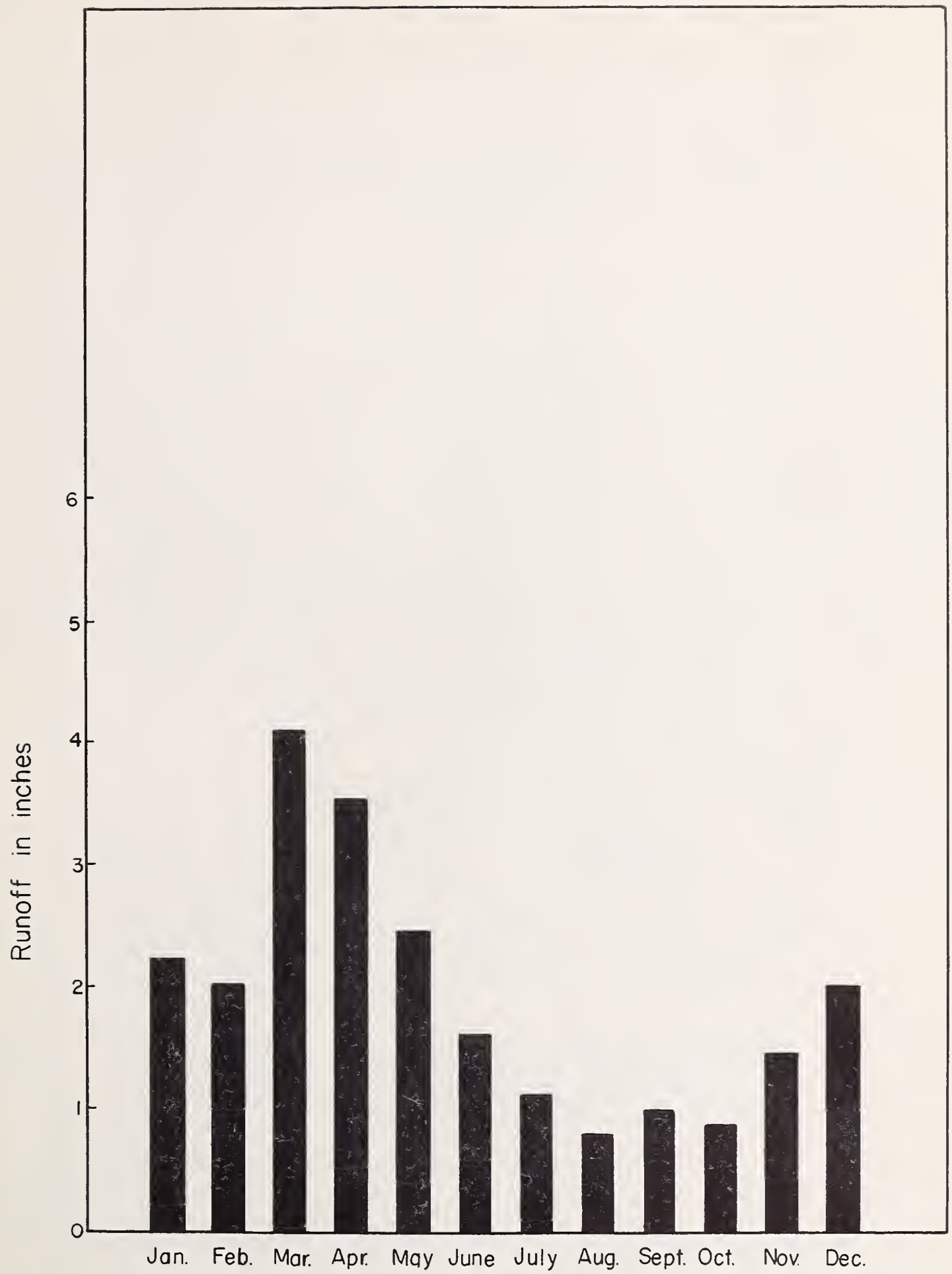


Figure I .- Average monthly runoff, Quinebaug River at Jewett City, 1918-1950

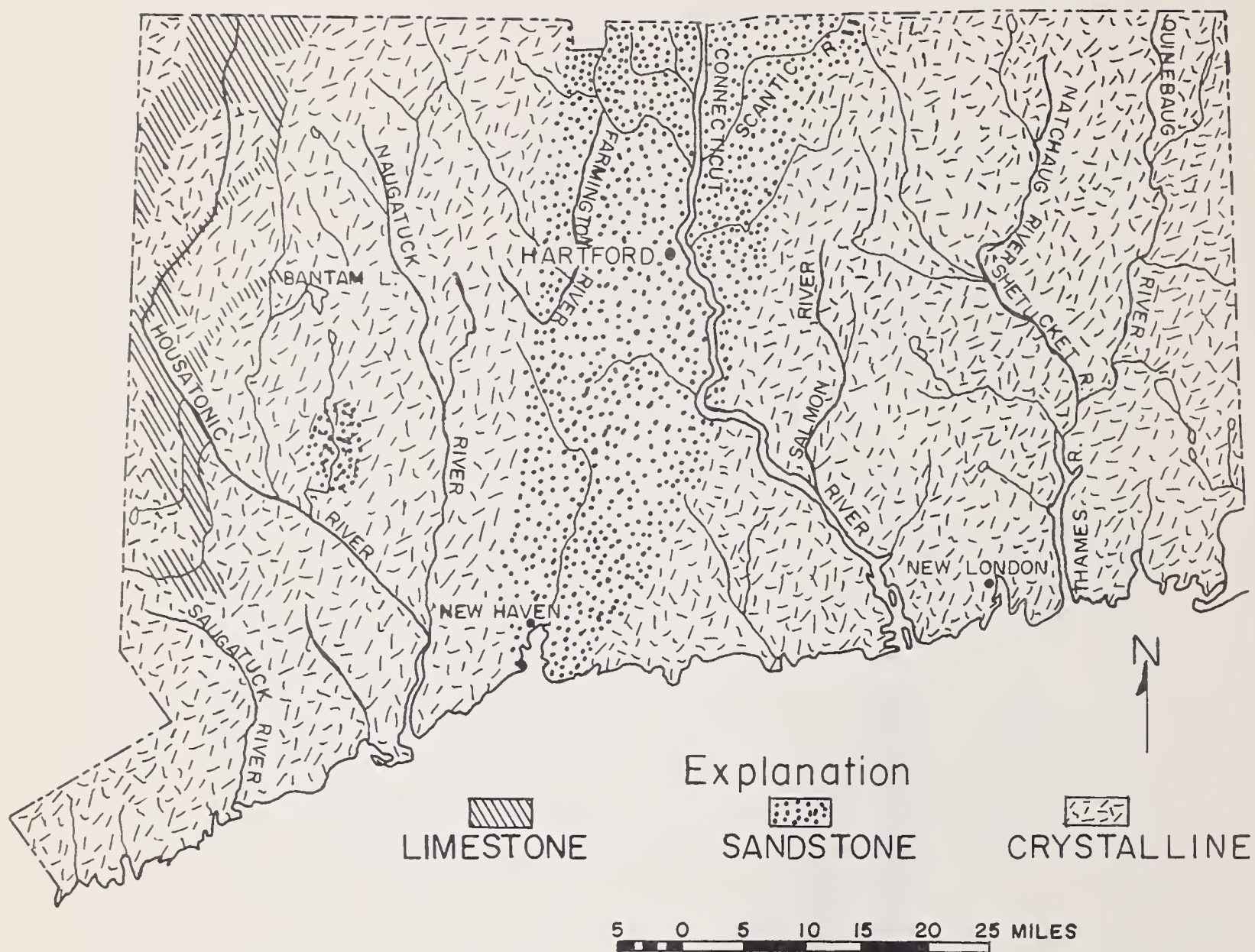


Figure 2.- Map showing areas of limestone, sandstone, and crystalline rock in Connecticut (after H.E. Gregory).

Practically all the crystalline rocks are transformed considerably from their original state as igneous or sedimentary rocks. The mineral components are mica, feldspar, quartz and amphibole. Of these feldspar and quartz are the principal components. The chemical composition of feldspar is that of a series of complex aluminum silicates combined with either potassium, sodium or calcium. Quartz consists of silica and oxygen.

The consolidated rocks of the Connecticut valley are the Triassic sediments composed chiefly of sandstone, shale, and basaltic lava or trap rock that are interbedded with the sediments. They underlie the greater part of the valley. The chemical composition of the sediments varies with the composition of the cementing agent that holds the grains together. Sandstones in the lower Connecticut valley have a reddish brown color which indicates cementation by iron oxide. However, silica, calcite, dolomite and in some instances halite may also be present. Shale, a fine-grained sedimentary rock, is composed primarily of clay minerals and mica; gypsum often is associated with shale.

Trap rock, usually dark colored, crops out in small areas in the lower and also along the western part of the upper Connecticut valley. Its mineral composition is not definitely known. Basically its chemical composition consists of silicates in various combinations with calcium, magnesium, aluminum, iron and other elements.

Very little of the limestone in the northwestern part of the state is pure limestone. The Paleozoic limestone is actually a dolomitic limestone. Its chemical composition is chiefly calcium carbonate and magnesium carbonate in varying proportions.

The unconsolidated deposits are mostly of glacial origin and include sand and gravel, silt and clay, and till composed of clay, sand, gravel and boulders. They are found practically everywhere in the State overlying the bed-rock but attain greatest prominence in the valleys of the larger streams and the coastal lowlands. The mineral composition of the unconsolidated material is equally varied and consists principally of silicate compounds of calcium, magnesium, iron, manganese, sodium and other elements.

These are the major sources of minerals in Connecticut. What is their contribution to the chemical quality of surface and ground waters in the state? What is the controlling influence? How does the chemical quality vary with time and place? These are some of the questions that will be considered in the following sections.

CHEMICAL QUALITY

HOUSATONIC RIVER BASIN

Surface Waters

During the period 1955-58 the chemical quality of surface waters in the Housatonic River basin ranged from good to fair. The range of dissolved solids was 32 to 216 ppm and of hardness was 13 to 180 ppm (tables 2 & 3). This broad range in quality reflected the diverse geology, streamflow conditions and, in some areas, industrial pollution. Although the chemical quality of all streams in the basin has not been studied, it is believed that the ranges given above include most major streams and many of the smaller streams.

To facilitate discussion, the basin has been subdivided into the upper and lower basins. The upper basin includes the main stem from the Massachusetts - Connecticut state line and the major tributaries, Blackberry, Tenmile and Still Rivers. The lower basin includes the main stem downstream from the confluence of Still and the Housatonic Rivers, and the major tributaries Shepaug, Pomperaug and Naugatuck Rivers (plate 1).

In the upper basin, broad to narrow areas of limestone are surrounded by crystalline rock (fig. 2). Although the mineral composition of the unconsolidated deposits has not been determined, it is assumed that the deposits are an admixture of weathered material from the bedrock, sand, gravel, and till.

Table 2.--PERIODIC ANALYSES OF STREAMS IN CONNECTICUT

HOUSATONIC RIVER BASIN

Source and Location	Date of Collection	Instantaneous Discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
															Calcium, magnesium	Non-carbonate			
Blackberry River at Canaan, Conn.	10-1-54 4-27-55	29 348	5.3 4.6	0.23 .09	23 10	11 4.0	2.7 1.1	2.0 1.3	108 39	14 10	4.9 2.8	0.9 .1	0.7 2.2	124 61	al03 all4	14 12	203 105	8.1 7.1	15 35
Housatonic River at Falls Village, Conn.	10-1-54 4-27-55	d388 d3,480	4.6 6.0	.35 .13	30 18	10 6.3	4.8 2.2	1.5 1.0	b130 75	12 9.8	5.0 3.0	.1 .0	1.9 1.3	146 89	all6 a73	14 11	236 159	8.4 7.3	8 25
" " " "	9-3-57	d121	3.2	.06	35	14	11	2.3	160	27	9.3	.0	2.8	188	145	14	331	7.2	10
" " " "	9-15-57	d209	4.0	.11	36	13	14	2.6	160	24	11	.1	2.2	191	144	13	332	7.4	7
" " " "	9-25-57	d406	5.3	.11	35	13	14	2.4	158	23	11	.2	3.6	190	141	12	329	7.3	7
" " " "	10-2-57	170	3.4	.24	32	11	11	2.2	140	23	9.2	.1	3.7	172	125	11	303	7.0	13
" " " "	10-15-57	123	2.8	.24	34	11	12	2.2	146	26	9.4	.1	2.5	183	130	11	319	7.0	7
" " " "	10-25-57	123	3.2	.06	33	13	13	2.2	145	34	11	.1	1.9	188	136	17	316	7.3	15
Tennille River near Gaylordsville, Conn.	9-17-53 4-19-54	41 820	4.9 5.1	.12 .31	42 24	18 9.7	4.8 2.1	3.8 1.1	176 98	37 19	7.8 3.8	.1 .2	1.3 2.2	216 132	al80 al00	35 20	348 204	8.2 7.3	12 12
Still River near Lanesville, Conn.	9-30-54 4-27-55	61 304	8.5 8.2	.38 .24	25 16	3.7 5.7	17 5.9	3.0 1.8	79 50	28 22	13 6.5	.1 .0	6.8 6.0	162 100	a78 a65	13 24	271 169	7.6 6.8	12 35
Shepaug River near Roxbury, Conn.	9-17-53 4-19-54	9.4 650	1.7 5.3	.16 .12	10 5.7	2.8 2.2	2.9 1.9	2.0 1.0	34 15	16 12	3.2 3.3	.0 .2	.4 2.0	61 51	36 23	9 11	94 64	7.1 6.2	8 23
Pomperaug River at Southbury, Conn.	9-17-53 4-19-54	7.6 302	6.6 7.0	.15 .15	13 5.5	3.3 1.6	3.6 2.9	1.4 .7	44 14	16 13	4.4 2.0	.0 .0	1.0 1.0	88 47	46 20	10 9	118 63	7.2 6.7	24 7
Housatonic River at Stevenson, Conn.	9-10-52 4-8-53	3,120 11,800	5.7 4.0	.11 .18	19 17	7.0 6.0	5.0 2.5	1.9 1.3	79 72	15 15	5.0 2.8	.3 .0	1.1 .4	112 94	76 67	11 8	164 151	7.3 7.2	15 17
" " " "	11-7-55	--	--	--	--	--	--	--	63	--	4.0	--	--	--	c64	12	137	7.2	--
" " " "	2-8-56	446	5.7	.14	20	6.7	4.4	1.9	80	--	5.9	.0	3.4	--	a78	12	186	7.1	5
Naugatuck River near Thomaston, Conn.	4-19-54 10-1-54 4-27-55	370 45 520	5.1 6.2 17	.23 .62 .42	5.4 7.9 5.1	2.2 2.0 1.7	2.2 12 2.9	1.0 2.5 .8	13 24 14	15 11 9.4	1.6 11 3.0	.0 .2 .1	.9 13 2.4	43 93 46	a24 a28 a20	13 8 9	60 130 68	7.6 7.6 6.4	9 10 13
Leadmine Brook near Thomaston, Conn.	10-1-57	0.3	2.9	.02	5.4	1.1	2.2	.9	13	8.0	3.5	.0	.0	32	18	8	50	6.2	6
" " " "	7-8-58	34	7.5	.08	4.5	1.2	2.4	.6	6	9.3	4.5	.1	.7	37	16	11	50	6.5	5
" " " "	4-10-58	114	4.7	.07	3.6	1.1	2.2	.5	5	10	3.0	.1	.4	32	14	10	40	6.0	4
" " " "	7-5-56	51	6.9	.24	3.6	1.0	1.4	.5	10	2.2	3.0	.1	.5	40	13	5	44	6.7	25
Naugatuck River at Beacon Falls, Conn.	10-1-57	d75	8.7	.22	16	5.0	26	4.3	10	93	14	.3	3.5	186	61	53	318	5.8	7
" " " "	1-7-58	d350	8.9	.52	9.5	2.3	11	2.0	2	36	9.0	.1	9.3	94	33	32	148	6.5	7
" " " "	4-10-58	1,120	5.8	.36	6.6	3.0	5.1	.4	7	23	5.2	.1	5.8	60	29	24	86	5.9	5
" " " "	7-9-58	282	6.2	.41	7.3	1.7	5.4	1.6	14	16	6.1	.0	5.8	64	25	14	93	7.3	13

a Includes hardness of all polyvalent cations reported

b Includes equivalent of 3 parts per million of carbonate (CO₃)

c By complexometric titration

d Daily mean discharge

Table 3. --SUMMARY OF CHEMICAL DATA
HOUSATONIC RIVER AT FALLS VILLAGE

October 1955 - September 1956

a Constituent	Minimum	bAverage	Maximum
Silica (SiO ₂)	2.6	5.5	7.6
Iron (Fe)	.06	.22	.53
Calcium (Ca)	14	26	35
Magnesium (Mg)	6.4	10	15
Sodium (Na)	2.4	5.9	12
Potassium (K)	.9	1.6	2.4
Bicarbonate (HCO ₃)	63	116	165
Sulfate (SO ₄)	10	16	22
Chloride (Cl)	3.0	6.6	11
Fluoride (F)	.0	.0	.2
Nitrate (NO ₃)	.6	2.1	3.2
Dissolved solids	86	137	184
c Total Hardness as CaCO ₃	61	108	149
Specific conductance (micromhos at 25 °C)	135	238	328
pH	7.0	--	7.7
Color	3	7	12
Oxygen Consumed, unfiltered samples	2.6	5.5	10
Oxygen Consumed, filtered samples	2.0	3.5	5.7

- a. In parts per million except pH, color and specific conductance.
b. Time-weighted.
c. Includes hardness of all polyvalent cations reported.

The presence of carbonate rock is reflected in the chemical composition of the water of the main stem and its tributaries. In the Housatonic River at Falls Village, for example, 82 percent of the dissolved constituents consisted of calcium, magnesium, and bicarbonate (fig. 3). Blackberry and Tenmile Rivers had a similar composition based on several analyses of water samples collected during high and low flows. The average content of calcium, magnesium, and bicarbonate was 81 to 83 percent respectively. Still River, however, reflected the changing downstream trend due to a decrease in drainage from limestone and an increase in drainage from crystalline rock; its average content of calcium, magnesium, and bicarbonate was 63 percent.

The chemical composition in all streams remained the same irrespective of streamflow but the concentrations of solutes fluctuated considerably. Here streamflow was a controlling factor (fig. 4 & 5). During high flow, dilution was effective in reducing concentrations of dissolved solids. This is a natural process. During period of heavy precipitation and accelerated surface runoff, time of contact with soils and rocks is shorter; less material is dissolved; and therefore concentrations of the solutes are less. The reverse is true during low flow when a large portion of streamflow consists of ground water inflow. Because ground water is usually more mineralized than surface water, concentrations of dissolved solids are increased.

Because the chemical composition is principally calcium, magnesium and bicarbonate, hardness is a prominent chemical characteristic of surface waters in the basin. It was higher in water in streams draining limestone areas - Tenmile River near Gaylordsville and Housatonic River at Falls Village. Downstream, as drainage from crystalline rock increased, hardness of the main stem and tributaries decreased (fig. 6). Here, too, streamflow had a modifying influence on the concentrations of calcium and magnesium; the constituents, which mainly cause hardness of water. Generally, the range of hardness was from low to moderate. In the basin, however, during a low flow period, hardness as high as 180 ppm was determined in a water sample from Tenmile River near Gaylordsville.

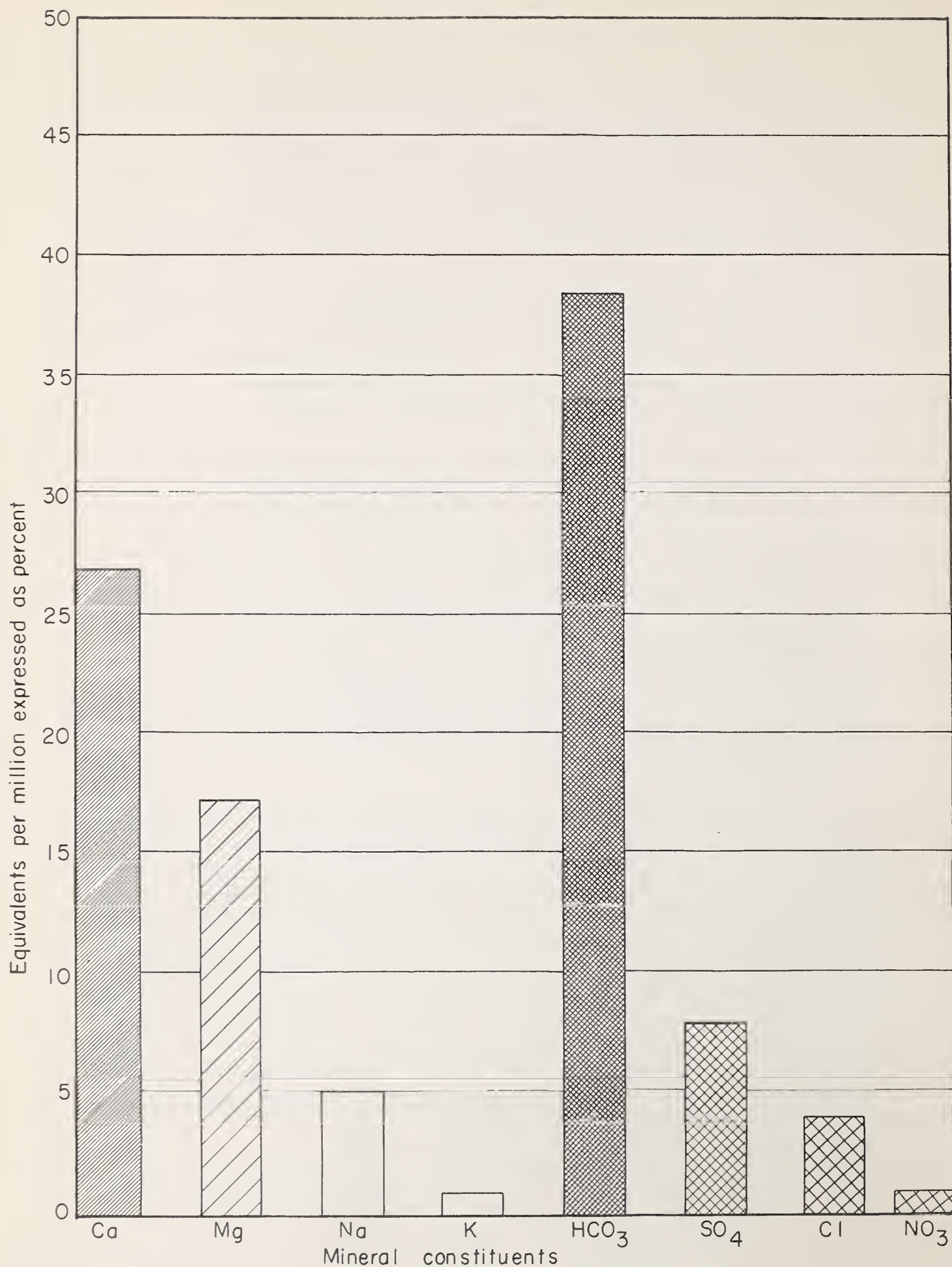


Figure 3 :- Average composition, Housatonic River at Falls Village, 1955-56

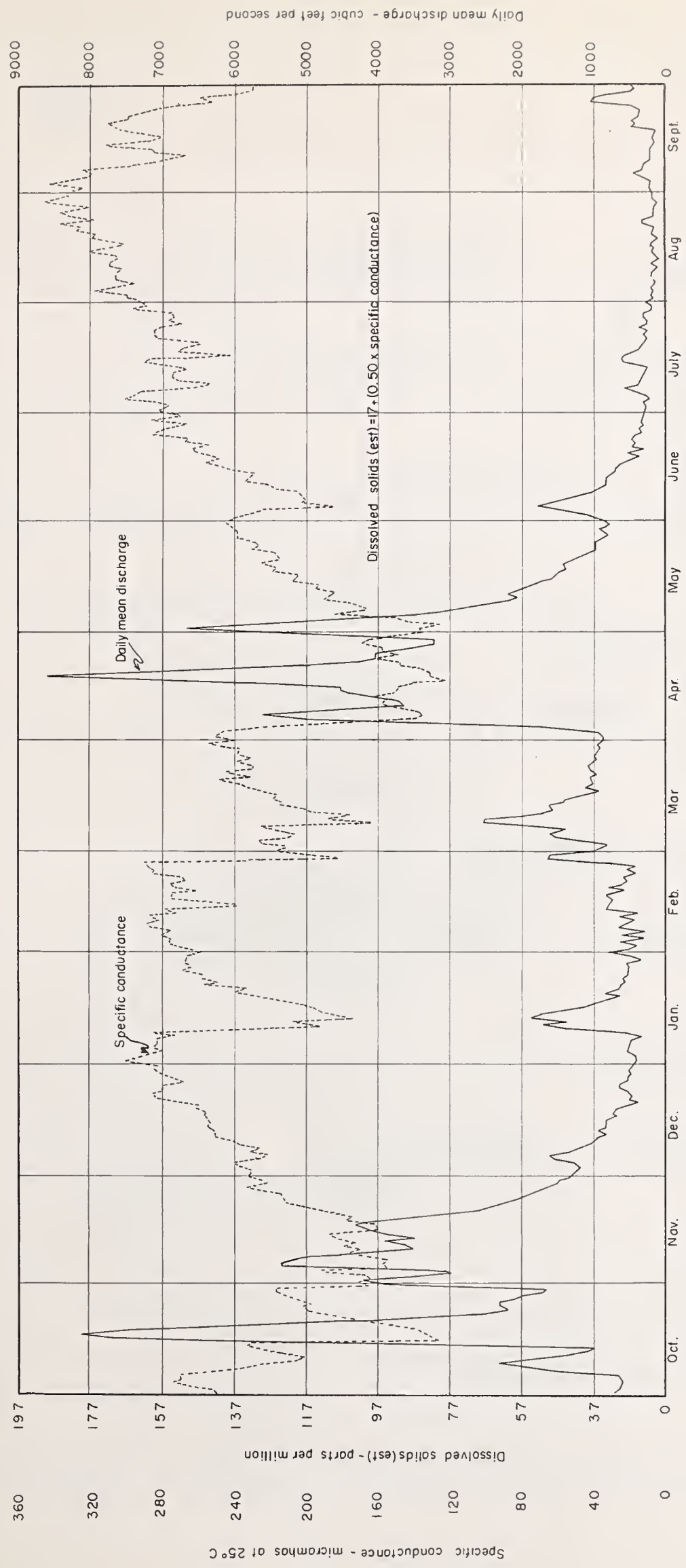


Figure 4 - Specific conductance and daily mean discharge, Hausatanic River at Falls Village, 1955-56

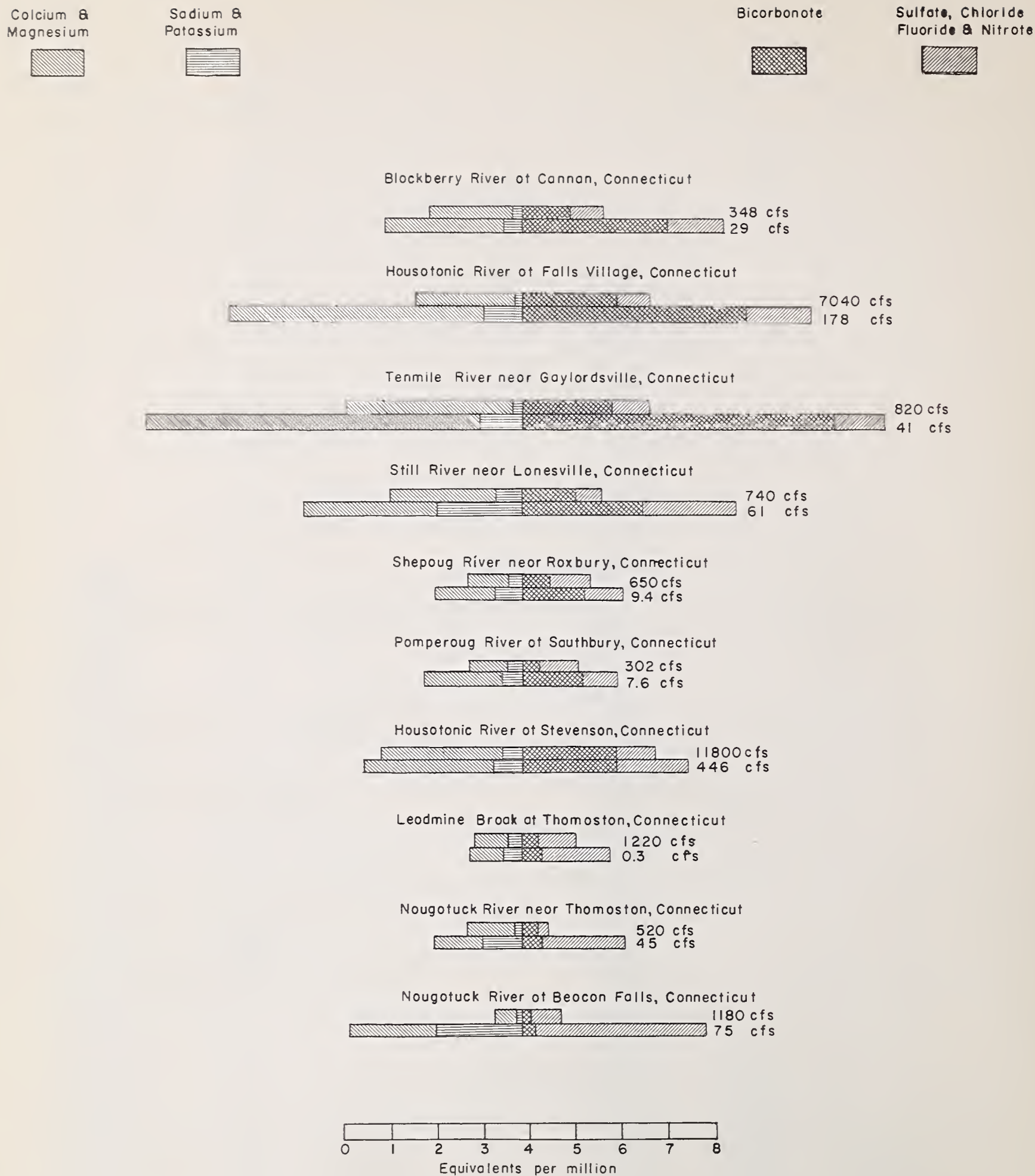


Figure 5.- Chemical composition of streams in the Housatonic River Basin at high and low discharges

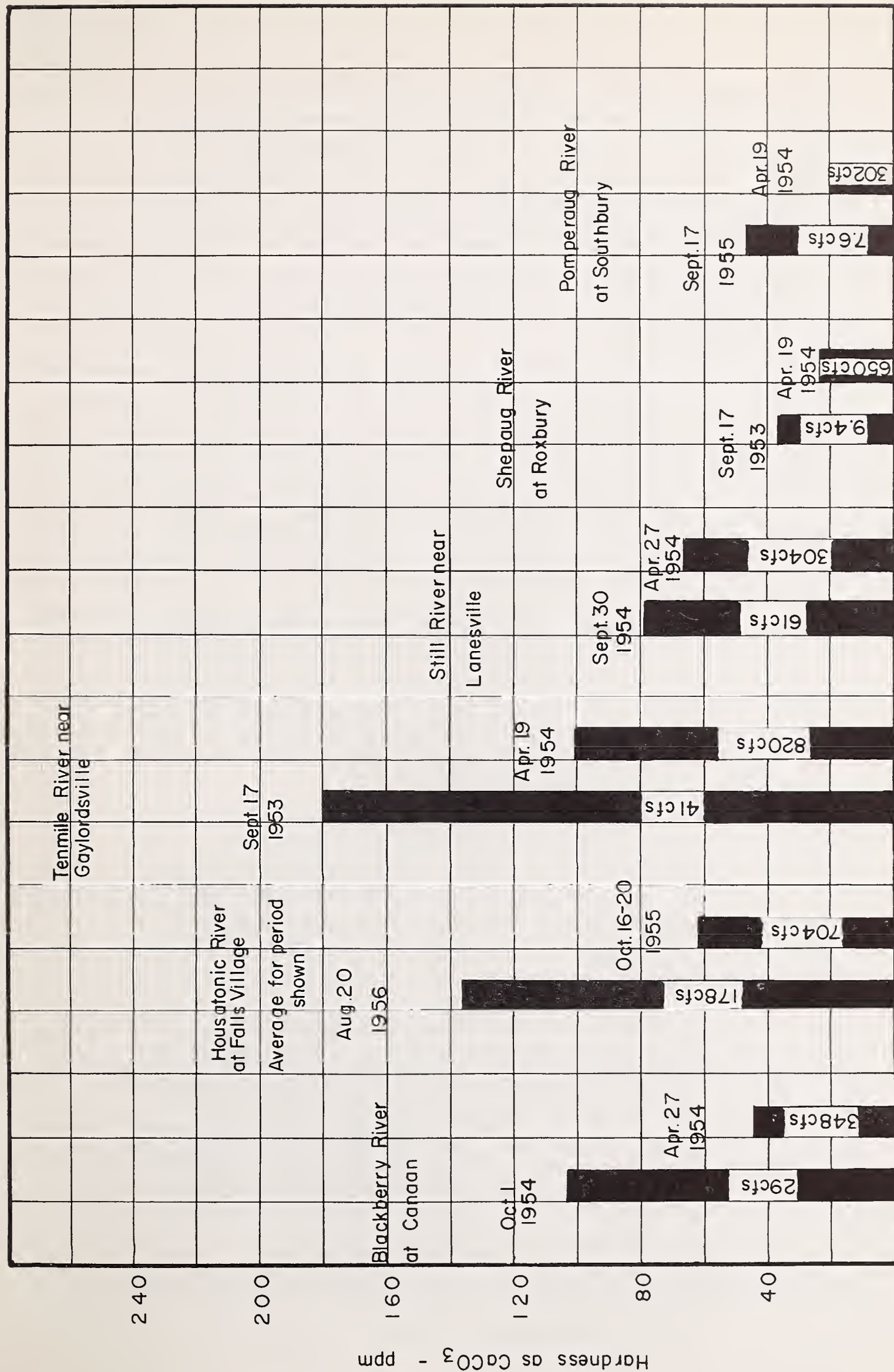


Figure 6.— Hardness of water from streams in the Housatonic River Basin during low and high stream discharge

Although calcium and magnesium are the predominant cations in surface waters in the upper Housatonic River basin, iron concentrations, at times, could be a problem (discussed in the section Water, Utility and Quality). Iron concentrations in excess of 0.3 ppm were present in water from the Housatonic River at Falls Village (fig. 7). Water from Tenmile and Still Rivers also contained high concentrations of iron. Blackberry River at Canaan usually contained less than 0.3 ppm. The occurrence of iron in these waters is probably due to the solution of iron from schists in the basin. These usually contain more iron than other crystalline rocks. Also, direct drainage from iron deposits is a likely source of iron as deposits of iron are scattered throughout the basin (although inoperative at the present time they were mined during the Revolutionary War). The reason for the very high iron concentrations of 2.6 and 1.7 ppm in the Housatonic River at Falls Village is not known; however, pollution is suspected. Further investigation is planned to relate iron in water resources in Connecticut and the "source of supply".

Other dissolved constituents such as sodium, potassium, sulfate, chloride, fluoride and nitrate accounted for approximately 15 to 30 percent of the solutes present in surface waters in the upper Housatonic River basin. However, the concentrations of these constituents are of lesser importance than the concentrations of constituents discussed above.

In the lower section of the Housatonic River basin, crystalline rock is the principal consolidated deposit and the unconsolidated material consists of sand, gravel and till. Consequently, concentrations of dissolved solids in surface waters were usually less than 100 ppm and the waters were soft to very soft in contrast to the higher concentrations of dissolved solids and hardness (as high as 216 and 180 ppm, respectively) in the upper basin. Water from the Naugatuck River, however, contained concentrations of dissolved solids almost as high as those in waters in the upper basin. The chemical composition also varied. Approximately equal amounts of bicarbonate and sulfate were present, and the pH values were higher. The variations in chemical quality in the Naugatuck are attributed to industrial pollution. This is a broad picture of the chemical quality of the lower section and does not tell the whole story.

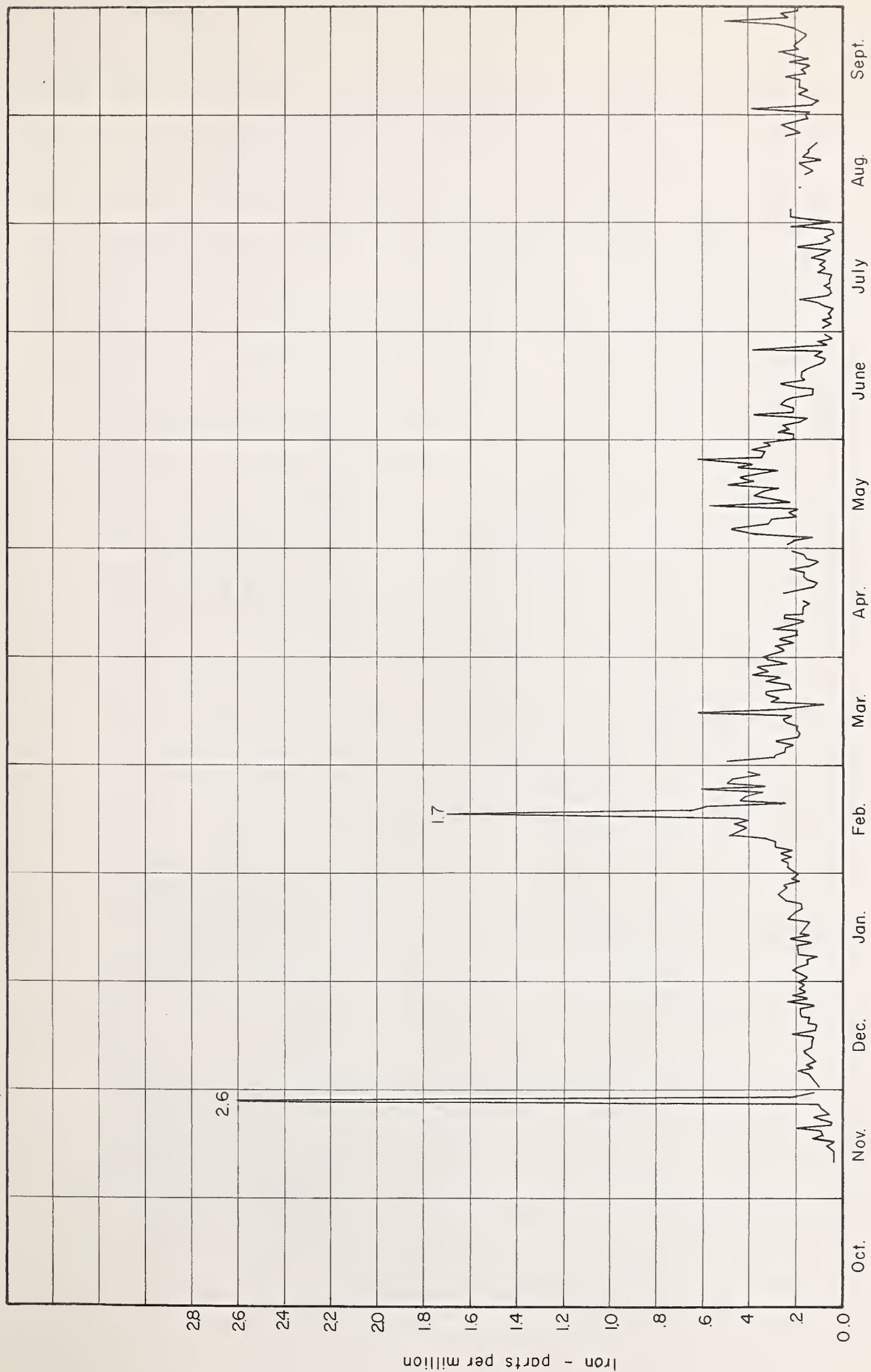


Figure 7 : Daily iron concentrations, Housatonic River at Falls Village, 1955 - 56

Several chemical analyses are available of water samples collected from the Shepaug and Pomperaug Rivers. These represent the chemical quality at high flows when dilution is effective, and at low flows when ground water drained from the crystalline rock maintained somewhat higher concentrations of dissolved solids (table 2). Based on available data, the range in concentrations of dissolved solids in water collected from Shepaug River near Roxbury was from 51 to 61 ppm, and the range of hardness was 23 to 36 ppm. In the Pomperaug River samples the range in dissolved solids was 47 to 88 ppm, and of hardness 20 to 46 ppm. These extremes do not necessarily represent the minimum and maximum but are believed to be representative.

Downstream, the chemical quality of water from Housatonic River at Stevenson was rather uniform irrespective of streamflow (fig. 5). Stevenson is about 0.2 mile downstream from Lake Zoar (storage reservoir on the Housatonic having a usable capacity of 331,000,000 cubic feet). It is believed that mixing within the reservoir is effective in maintaining the uniform quality at this downstream location.

The chemical quality of water from Naugatuck River fluctuated considerably during 1957-58. Dissolved solids, in composites of daily water samples collected at Thomaston, range from 46 to 171 ppm (table 4). Daily fluctuation in solute material based on specific conductances (an approximate measure of dissolved solids) are even more striking (fig. 8).

During low flow (usually less than 10 cfs) abrupt changes in chemical quality occurred from day to day. Calcium concentrations increased about twofold; magnesium and potassium concentrations changed only slightly; and sodium concentrations increased approximately 4 to 6 fold. Iron concentrations were highest during the low flow period (fig. 9).

Of the anions, bicarbonate concentrations decreased with increasing acidity. As concentrations of bicarbonate decreased sulfate concentrations rose and, at times, exceeded those for bicarbonate. Zero concentration of bicarbonate was determined on November 17, 1957 when pH of the stream was 4.5; usually indicative of contamination by acid wastes. Water from Naugatuck River also contained no bicarbonate on April

Table 4. --SUMMARY OF CHEMICAL DATA,
NAUGATUCK RIVER NEAR THOMASTON

October 1957 - September 1958

a Constituent	Minimum	bAverage	Maximum
Silica (SiO ₂)	6.3	9.2	17
Iron (Fe)	.09	.37	1.4
Calcium (Ca)	6.4	9.2	15
Magnesium (Mg)	1.8	2.9	4.9
Sodium (Na)	2.7	8.3	25
Potassium (K)	.8	1.9	4.8
Bicarbonate (HCO ₃)	c0	24	100
Sulfate (SO ₄)	10	20	30
Chloride (Cl)	1.2	7.1	13
Fluoride (F)	.0	.2	.4
Nitrate (NO ₃)	.6	7.9	29
Dissolved solids	46	82	171
Hardness as CaCO ₃ (calcium & magnesium)	22	38	80
Specific conductance (micromhos at 25 °C)	68	129	357
pH	4.5	--	9.1
Color	3	9	33
Oxygen Consumed, unfiltered samples	5	--	14
Oxygen Consumed, filtered samples	2	--	5

a. In parts per million except pH, color and specific conductance.

b. Time-weighted.

c. When pH was 4.5 and 9.1. At a pH of 9.1, alkalinity consisted of 35 ppm carbonate (CO₃) and 1 ppm hydroxide (OH).

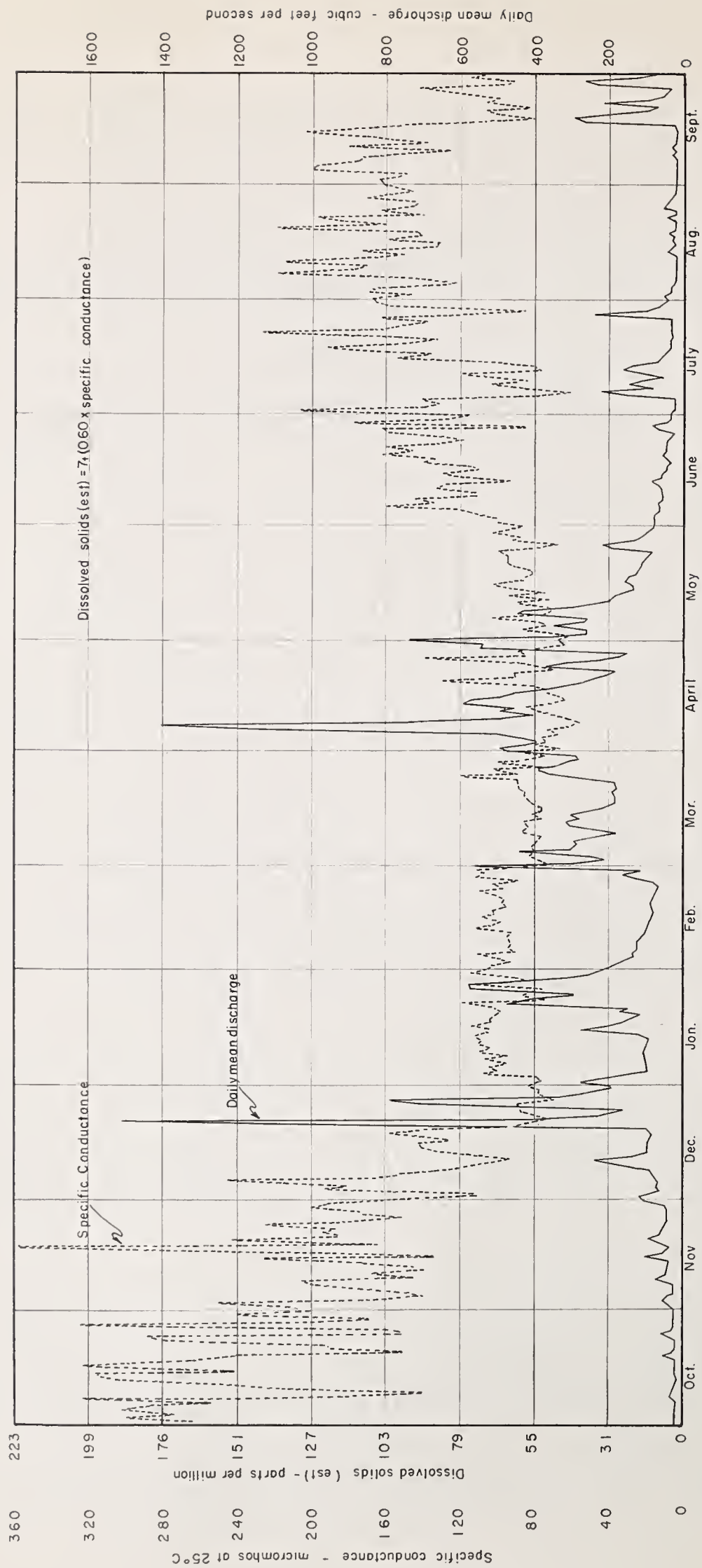


Figure 8.— Specific conductance and daily mean discharge, Naugatuck River near Thomaston, 1957 - 58

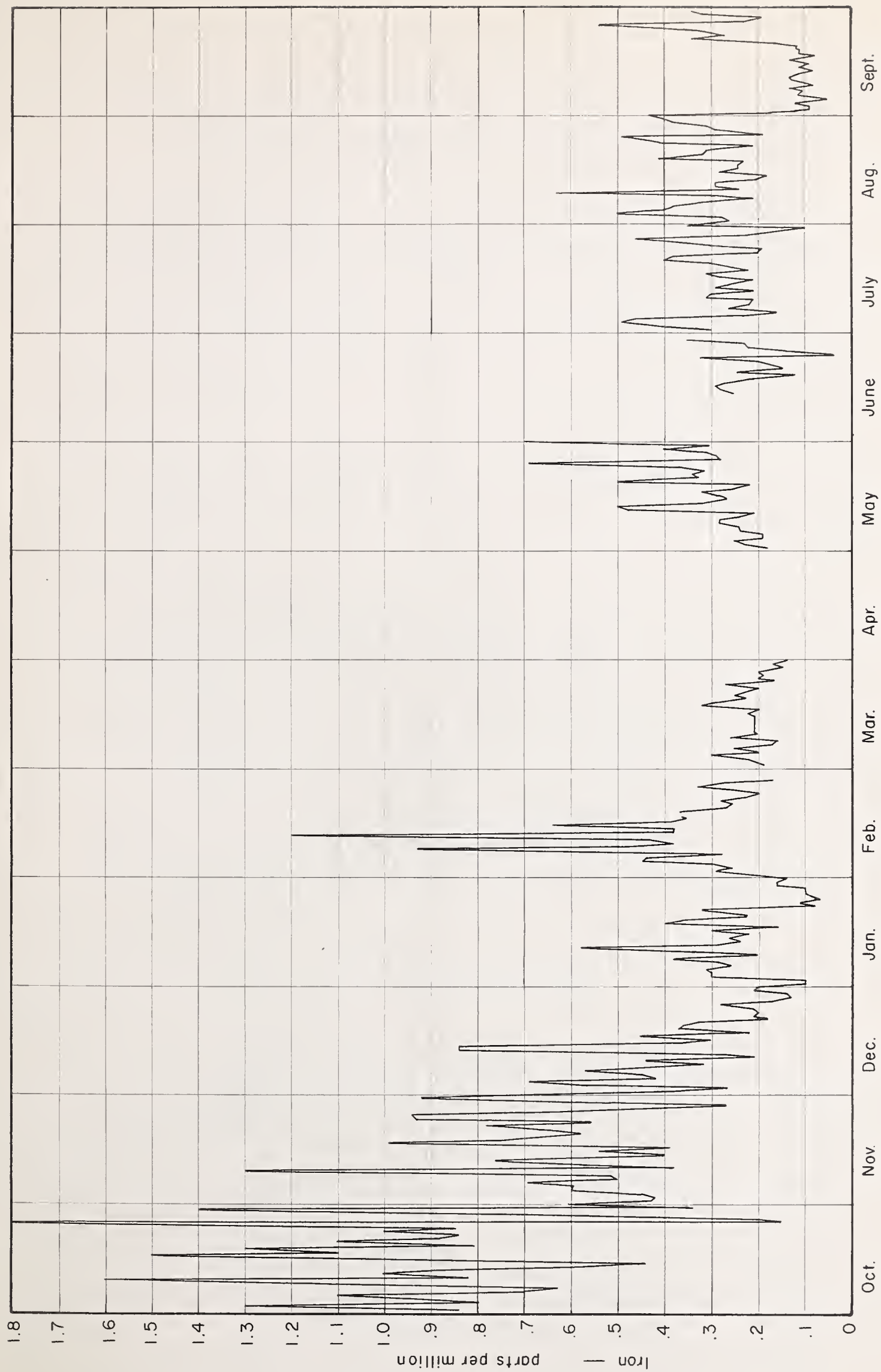


Figure 9.- Daily iron concentrations of the Naugatuck River near Thomaston, 1957 - 58

19, 1958 when the pH rose to 9.1; alkalinity consisted of 35 ppm of carbonate and 1 ppm of hydroxide (table 4). These are extremes. Generally, the pH fluctuated between 6 and 7.

The changing chemical composition of the Naugatuck River was also reflected in its hardness. At Thomaston the water was usually soft with a range of hardness from 22 to 80 ppm. Because of the increased concentrations of sulfate, non-carbonate hardness equalled (once) but never exceeded carbonate hardness. The conclusion is based on data obtained from analyses of composite samples so it may not apply to day to day changes.

As streamflow increased, dilution had a modifying effect on the concentration of dissolved solids as well as the chemical composition of water from Naugatuck River (figs. 5 & 8).

Leadmine Brook, a tributary of the Naugatuck River, showed very little change in chemical quality irrespective of streamflow (fig. 5). The brook drains crystalline rock covered with a thin layer of surficial material. Streamflow appears to be sustained principally by surface water runoff and, apparently, very little ground water inflow; during protracted periods of no precipitation, the brook is dry. Consequently, it is believed that the chemical quality reflects the contribution of solutes from surface runoff with very little addition of more mineralized matter from ground water inflow. Because of these conditions, the chemical quality does not vary significantly with changes in streamflow.

Ground Water

Only a few chemical analyses of ground water in the Housatonic River basin are available and a comprehensive picture of the chemical quality cannot be presented at this time (table 5). Well data appear in table 6.

Table 5.-CHEMICAL ANALYSES OF WATER FROM WELLS IN THE HOUSATONIC RIVER BASIN

Chemical analyses in parts per million																				
Well Number 1/ 2/	Date of collection	Tem- pera- ture (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids	Hardness as CaCO ₃ Calcium magnesium	Non- car- bonate	Specific conductance (micromhos at 25°C)	pH	Color
Upper Basin																				
Cn-2	June 4, 1953	49	5.2	0.03	0.02	43	21	4.1	4.1	215	23	1.7	0.0	0.2	205	194	17	366	7.8	2
Sy-2	June 4, 1953	47	10	.02	.02	2.8	1.0	2.6	2.6	13	4.8	.4	.0	.5	32	11	0	32	6.5	3
Sy-3	June 4, 1953	49	10	.27	.22	58	31	8.6	8.6	332	16	1.8	.1	.5	291	272	0	516	7.8	2
Sy-4	June 4, 1953	48	9.9	.11	.13	52	22	6.8	6.8	250	28	.9	.0	.3	243	220	15	423	7.7	2
Lower Basin																				
Na-31b/	May 13, 1954	53	18	5.0	9.9	52	10	18	4.0	82	128	28	.1	.4	356	171	134	478	6.5	15
Wb-3	May 13, 1954	--	14	.01	.02	23	5.6	12	2.5	48	44	10	.0	16	151	80	41	229	6.6	5
Wb-10	Apr. 28, 1954	--	15	.05	.01	37	12	17	3.4	39	96	18	.0	33	275	142	110	382	6.4	5
Wb-11c/	Apr. 28, 1954	--	15	.06	5.6	52	16	33	4.8	130	107	41	.0	18	373	196	89	565	6.8	3
Wb-12	May 13, 1954	53	9.4	.03	.02	9.5	1.8	6.3	1.0	26	15	4.5	.0	6.5	80	31	10	103	6.6	4
Wb-16	May 13, 1954	59	14	.01	3.6	18	4.3	8.0	2.7	8.2	79	7.1	.2	.1	146	63	56	204	5.4	5
Wb-17	May 1954	--	21	.02	1.5	16	3.8	10	2.7	19	56	8.0	.0	6.8	151	56	40	194	6.1	5
Wb-334/335d/	Apr. 28, 1954	52	7.5	.05	.02	12	2.4	6.3	1.3	28	21	6.2	.0	3.5	90	40	17	122	6.5	5
Wb-339	Apr. 29, 1954	52	16	.12	4.1	38	12	29	3.7	71	140	15	.2	4.0	300	144	86	452	6.4	5

1/ See table 6 for well data
2/ See Plate 2 for approximate location of wells
b/ Ranney Water Collector
c/ Chemical analysis is for a mixed water sample from 3 wells
d/ Chemical analysis is for a mixed water sample from 2 wells

TABLE 6. -- DATA OF WELLS IN THE HOUSATONIC RIVER BASIN

Well No.	Depth (feet)	Diam. (inches)	Water-bearing formation	Yield gpm	Owner Location
Cn-2	162	6	Stockbridge limestone equivalent	15	F. Green, Canaan, Conn.
Na-31 <u>a/</u>	90	18 ft.	Glacial drift on bedrock	1750	Naugatuck Chemical Co., Naugatuck, Conn.
Sy-2	72	6	Berkshire schist equivalent	3	Mrs. O'Brien, Mt. Riga: 3 mi. N. W. of Salisbury, Conn.
Sy-3	210	6	Stockbridge limestone equivalent	25	G. Miner, Lakeville, Conn.
Sy-4	120	6	Stockbridge limestone equivalent	3/4	C. Linschide, Lakeville, Conn.
Wb-3	35	10	Pleistocene sand & gravel	200	Scoville Mfg. Co., Waterbury, Conn.
Wb-10	31	8	Pleistocene sand & gravel	300	Thin Sheet Metal Co., Waterbury, Conn.
Wb-11 <u>b/</u>	52-55	36	Pleistocene sand & gravel	600	Plume and Atwood Mfg. Co. Waterbury, Conn.
	52-55	36	Pleistocene sand & gravel		
	52-55	36	Pleistocene sand & gravel		
Wb-12	75	--	Pleistocene sand & gravel	25	Waterbury Steel Ball Co., Waterbury, Conn.
Wb-16	50	10	Pleistocene sand & gravel	300	Chase Brass Co., Waterville, Conn.
Wb-17	51	10	Pleistocene sand & gravel	300	Chase Brass Co., Waterville, Conn.
Wb-334	59	10	Pleistocene sand & gravel	250	The Bristol Co., Waterbury, Conn.
335 <u>c/</u>	63	10	Pleistocene sand & gravel	120	
Wb-339	40	10	Pleistocene sand & gravel	200	Conn. Light & Power Co., Waterbury, Conn.

a/ Ranney Water Collectorb/ Dimensions are for 3 wells from which a mixed water sample was collectedc/ Dimensions are for 2 wells from which a mixed water sample was collected

In the upper basin, near Salisbury, water obtained from two wells in crystalline rock, is very low in dissolved solids and hardness - 32 and 11 ppm, respectively. In sharp contrast, water from wells in limestone contains 6 to 8 times as much dissolved solids and hardness is about 20 times as high. Because the water-bearing formation appears to be dolomitic limestone, the chemical composition consists principally of calcium, magnesium, and bicarbonate. The ratio of equivalents of calcium to those of magnesium is about 1.2 to 1. In well number Sy-3 the concentration of iron and manganese totaled 0.49 ppm (table 5).

The chemical quality of ground water from shallow wells in sand and gravel deposits in the Waterbury area varies widely. Concentrations of dissolved solids in water from several wells ranged from 80 to 373 ppm and hardness ranged from 31 to 196 ppm (table 5). Moreover, the concentrations of most constituents also varied widely especially those for sulfate, bicarbonate, calcium and manganese. Such high concentrations, for example, as 9.9 ppm for manganese and 140 ppm for sulfate, as well as the wide ranges cannot be explained on the basis of the mineralogic characteristics of the water-bearing formation. Surface contamination is a possibility. More so, the sand and gravel aquifers are in contact with the Naugatuck River and are recharged, in part, by infiltration of water from the river. Thus, it is believed that the water of poor quality from the river contributes to the mineral content of water from sand and gravel deposits. As to the wide ranges, rate and duration of pumping, and distance from the river are controlling factors. On the basis of present findings, further study of the chemical quality of ground water in the Waterbury area is indicated and will be included in future programs.

Summary

The chemical quality of surface waters in Housatonic River basin reflects the influence of diverse geology, stream-flow and to a lesser extent industrial pollution. In the upper part of the basin, waters in streams draining the limestone areas have a chemical composition consisting principally of calcium and bicarbonate, contain comparatively higher

concentrations of dissolved solids (as much as 216 ppm) and are moderately hard. In the lower part of the basin, water in streams, draining crystalline rock, is usually low in dissolved solids and soft. However, iron concentrations are usually higher. Stream pollution is present in some areas in the basin especially in the Naugatuck, and unusual changes in chemical quality are attributed to it. Chemical analyses of ground waters in the upper basin show wide differences in the chemical quality between ground water obtained from crystalline rock and that obtained from dolomitic limestone. The chemical quality of some ground waters from sand and gravel in the Naugatuck River valley in and near Waterbury shows the effect of infiltration of water of poor quality from the river. Others appear to be unaffected and have a more desirable chemical quality.

CONNECTICUT RIVER BASIN

Surface Waters

A casual evaluation of the chemical quality of the Connecticut River and its tributaries might be misleading. Being an interstate river flowing through industrialized areas, the Connecticut and many of its tributaries are polluted in varying degrees by inflow of domestic sewage and industrial wastes. It could well be concluded that the chemical quality of the surface waters has deteriorated beyond the point of no return. Unfortunately, no data are available that show what the chemical quality was long ago. In some of the smaller streams, especially during low flow, the poor chemical quality is attributable to pollution. Yet the mineral content of some streams, especially the Connecticut and Farmington Rivers, does not appear to be unusual in view of the geology in the basin.

In contrast to the diverse geology in the western highlands, bedrock in the central lowland consists mainly of Triassic shales and sandstone. Pre-Triassic crystalline rocks occur in the lower part of the basin. Overlying the bedrock are unconsolidated deposits of till, sand, and gravel. Minerals in these deposits are moderately soluble and contribute only small quantities of solutes.

In water from the Connecticut River at Thompsonville, dissolved solids ranged from 46 to 91 ppm (table 7). Dissolved solids in samples collected from the Farmington River at Rainbow were slightly less - 43 to 80 ppm (table 8). Water from both rivers was very soft. During the same period and at the same locations shown above, hardness of water from the Connecticut River ranged from 24 to 53 ppm and of the Farmington River, 20 to 60 ppm. The chemical quality of some of the smaller tributaries such as the Salmon River near East Hampton was similar to that of the major rivers. Other small streams such as the Scantic and Park Rivers had a much wider range in dissolved solids. Upper limits were 138 and 199 ppm respectively (table 9). These concentrations were determined on water samples collected during low flow and the increase can, in part, be attributed to pollution.

Although concentrations of dissolved solids were low, iron concentrations could become a problem. Iron is quite prevalent in most surface and ground waters throughout the State. As mentioned earlier, the reddish brown color of the sandstone in the basin is due to iron oxide present as a cementing agent; iron carbonate and hydroxide may also be present. These same iron compounds can also be present in the unconsolidated deposits. So the iron in water is obtained from these sources of supply. Industrial wastes may also be a contributing source of iron. In water from the Connecticut River, especially, iron concentrations fluctuated within a wide range - 0.15 to 1.3 ppm (fig. 10). Some of the tributaries also contained high concentrations of iron (table 9).

Although the minerals of the rocks and waste effluent contributed to the solute content of streams in the basin, dilution, especially during periods of high streamflow, was effective in reducing concentration of solute material (fig. 11 & 12). However, reduction of concentration by dilution is not

Table 7. --SUMMARY OF CHEMICAL DATA,
CONNECTICUT RIVER AT THOMPSONVILLE

October 1955 - September 1956

a Constituent	Minimum	bAverage	Maximum
Silica (SiO ₂)	1.8	5.8	8.5
Iron (Fe)	.15	.39	1.3
Calcium (Ca)	6.2	10	15
Magnesium (Mg)	1.3	1.9	3.3
Sodium (Na)	2.7	4.9	8.0
Potassium (K)	.9	1.4	1.9
Bicarbonate (HCO ₃)	17	28	51
Sulfate (SO ₄)	7.5	13	18
Chloride (Cl)	2.9	6.3	11
Fluoride (F)	.0	.1	.2
Nitrate (NO ₃)	.1	2.2	3.8
Dissolved solids	46	67	91
c Total Hardness as CaCO ₃	24	34	53
Specific conductance (micromhos at 25°C)	67.5	103	149
pH	6.1	--	7.1
Color	5	8	15
Oxygen Consumed, unfiltered samples	4.2	8.4	14
Oxygen Consumed, filtered samples	3.5	4.8	6.8

a. In parts per million except pH, color and specific conductance.

b. Time-weighted.

c. Includes hardness of all polyvalent cations reported.

Table 8. --SUMMARY OF CHEMICAL DATA
FARMINGTON RIVER AT RAINBOW

October 1957 - September 1958

a Constituent	Minimum	bAverage	Maximum
Silica (SiO ₂)	5.1	8.4	12
Iron (Fe)	.10	.21	.44
Calcium (Ca)	5.6	9.1	12
Magnesium (Mg)	1.4	2.0	3.0
Sodium (Na)	2.6	4.5	6.1
Potassium (K)	.7	1.1	1.7
Bicarbonate (HCO ₃)	10	26	56
Sulfate (SO ₄)	9.6	14	24
Chloride (Cl)	3.4	5.2	6.6
Fluoride (F)	.0	.1	.3
Nitrate (NO ₃)	.7	3.0	4.9
Dissolved solids	43	64	80
Hardness as CaCO ₃ (calcium & magnesium)	20	33	60
Specific conductance (micromhos at 25°C)	62	95	148
pH	6.3	--	7.2
Color	3	8	20
Oxygen Consumed, unfiltered samples	3	--	8
Oxygen Consumed, filtered samples	2	--	4

a. In parts per million except pH, color and specific conductance.
b. Time-weighted.

Table 9.--PERIODIC ANALYSES OF STREAMS IN CONNECTICUT

CONNECTICUT RIVER BASIN

Source and Location	Date of Collection	Instantaneous Discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
															Calcium magnesium	Non-carbonate			
Connecticut River at Thompsonville, Conn.	10-10-52 5-3-53	4,320 1,700	3.0 4.5	0.50 .14	16 8.6	1.5 1.1	7.0 2.3	2.3 .9	4.2 20	18 13	5.8 1.8	0.2 .1	1.6 1.1	84 63	16 26	12 10	133 66	7.0 7.2	20 18
Scout River at Broad Brook, Conn.	9-11-52 10-10-52	35 53	9.2 11	.16 .14	23 22	5.5 3.2	8.3 11	1.3 1.9	44 38	45 43	8.8 5.8	.3 .1	4.3 1.9	137 138	80 68	44 40	199 210	7.1 7.1	5 13
" " "	3-31-53 6-25-56	1,120 74	-- 8.9	.33 --	6.0 18	1.3 3.4	5.4 3.7	.8	9 33	16 29	2.5 6.2	-- .1	1.2 7.1	-- 104	20 59	13 32	63 154	6.2 6.6	33 9
Farmington River at Rainbow, Conn.	9-11-52 4-8-53	1,940 4,200	6.6 5.1	.55 .29	10 6.3	2.8 1.2	4.5 2.5	1.3 .8	30 16	15 12	4.8 3.0	.3 .1	1.5 1.0	77 49	36 21	12 8	95 61	6.6 6.4	10 27
Park River at Hartford, Conn.	9-18-53 4-17-54	36 265	7.7 8.0	2.1 .66	28 16	5.7 5.1	25 6.3	2.8 1.7	94 45	69 28	7.7 6.0	.5 .0	1.7 2.7	199 131	93 61	16 24	322 166	7.7 6.6	25 15
Hockanum River at East Hartford, Conn.	4-27-56	400	9.8	.17	11	2.4	6.0	1.2	22	19	6.8	.1	6.4	74	37	19	119	6.5	25
Salmon River near East Hampton, Conn.	9-17-53 4-20-54	6.8 430	7.9 6.0	.24 .19	5.1 3.4	1.1 1.7	5.4 2.4	2.0 .6	13 5.9	18 9.6	3.5 4.8	.1 .1	.7 .8	66 39	17 16	7 11	78 43	7.1 5.8	23 25
Connecticut River near Middletown, Conn.	9-17-53 4-14-54	-- 56,200	1.0 4.7	.60 .43	17 8.9	2.0 1.1	7.0 2.1	2.2 1.0	42 21	22 10	7.5 4.1	.1 .2	1.4 1.4	102 54	51 27	16 10	144 71	7.1 6.4	15 18
East Dr. Elghtmile River near North Lyme, Conn.	5-4-56	76	3.3	.17	3.1	1.2	2.5	.6	9	6.0	3.7	.0	.5	30	13	5	43	6.7	17
West Br. Elghtmile River at North Plain, Conn.	5-4-56	64	4.7	.20	2.2	1.5	2.0	.6	7	6.9	2.3	.1	.1	26	12	6	34	6.5	7

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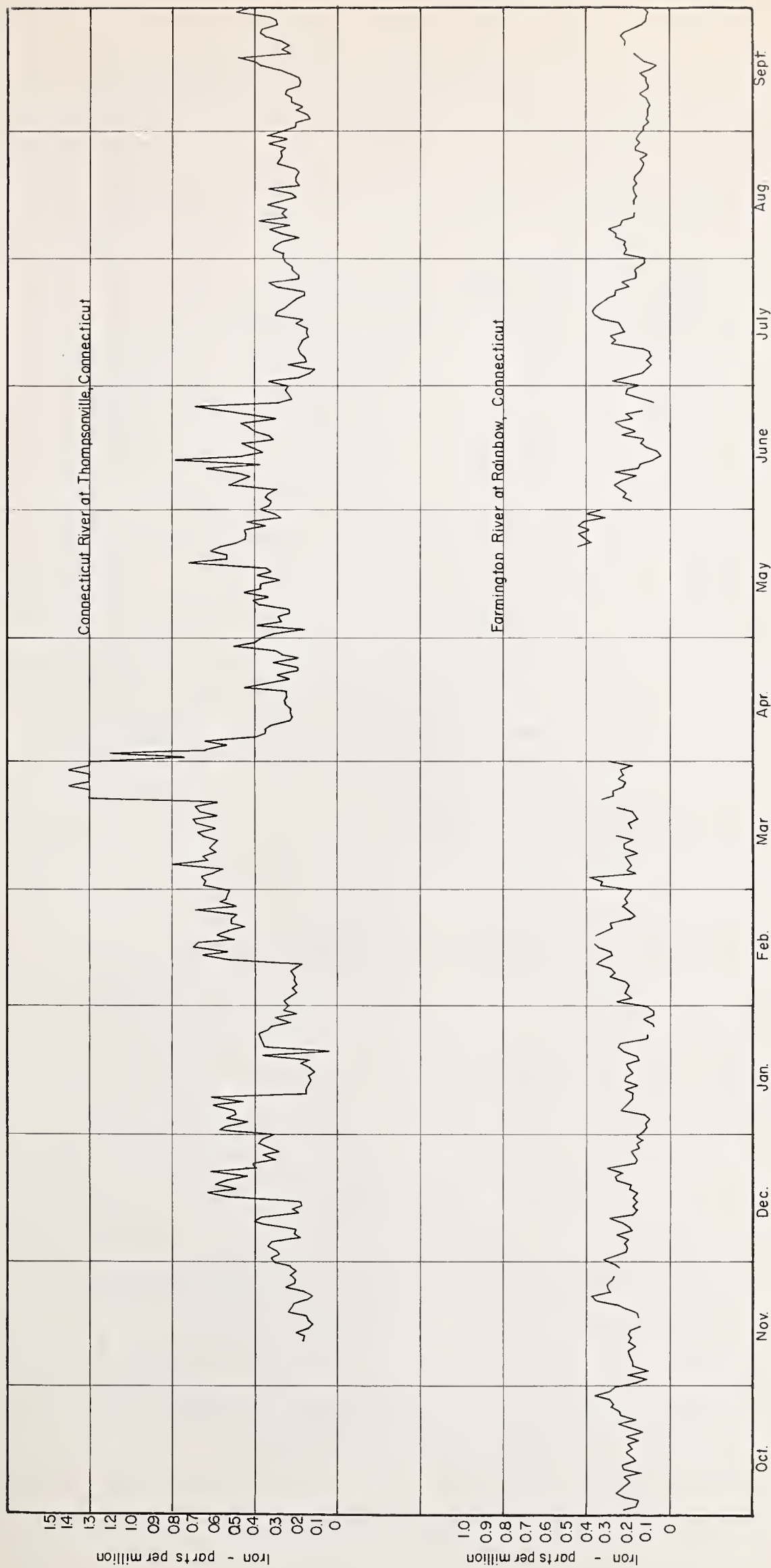


Figure 10: Daily iron concentrations of the Connecticut River at Thompsonville, 1955-56 and Farmington River at Rainbow, 1957-58

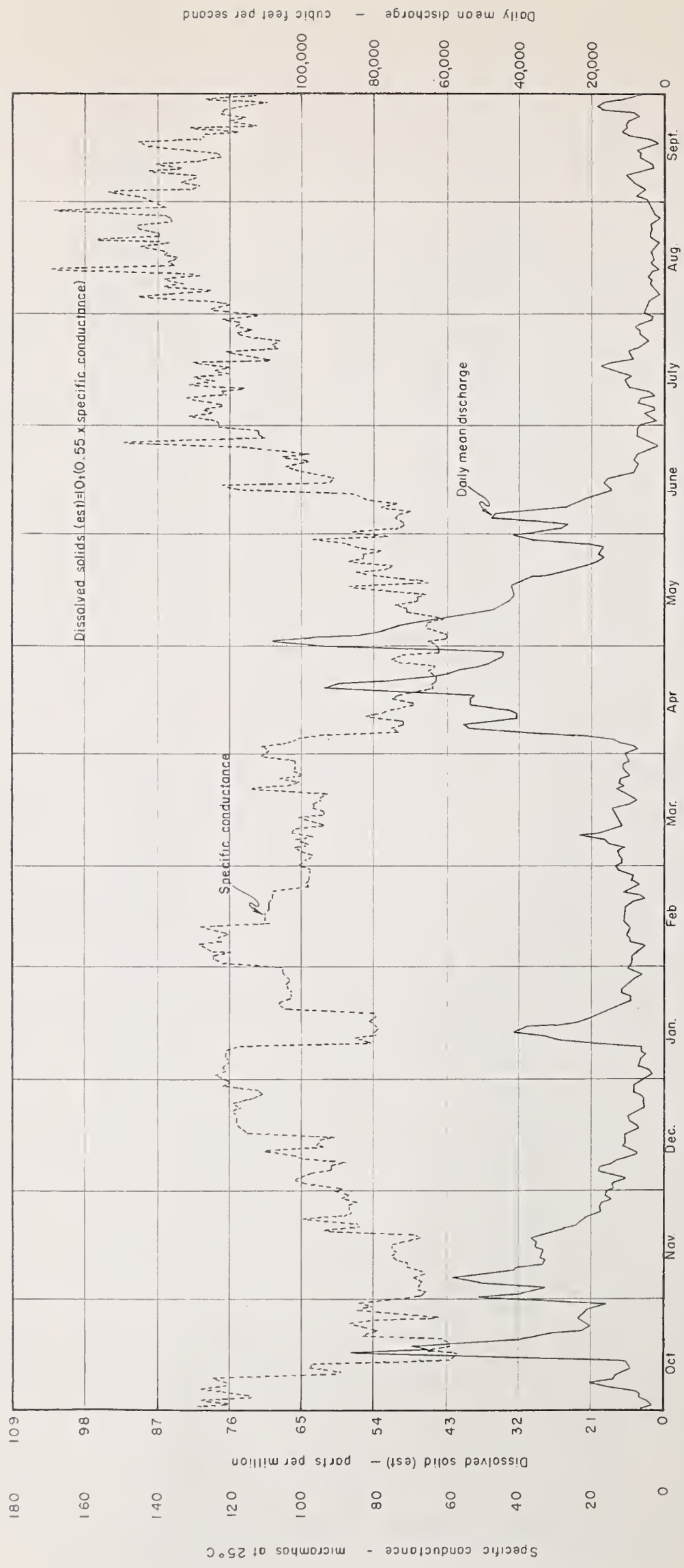


Figure 11 - Specific conductance and daily mean discharge, Connecticut River at Thompsonville, 1955 - 56

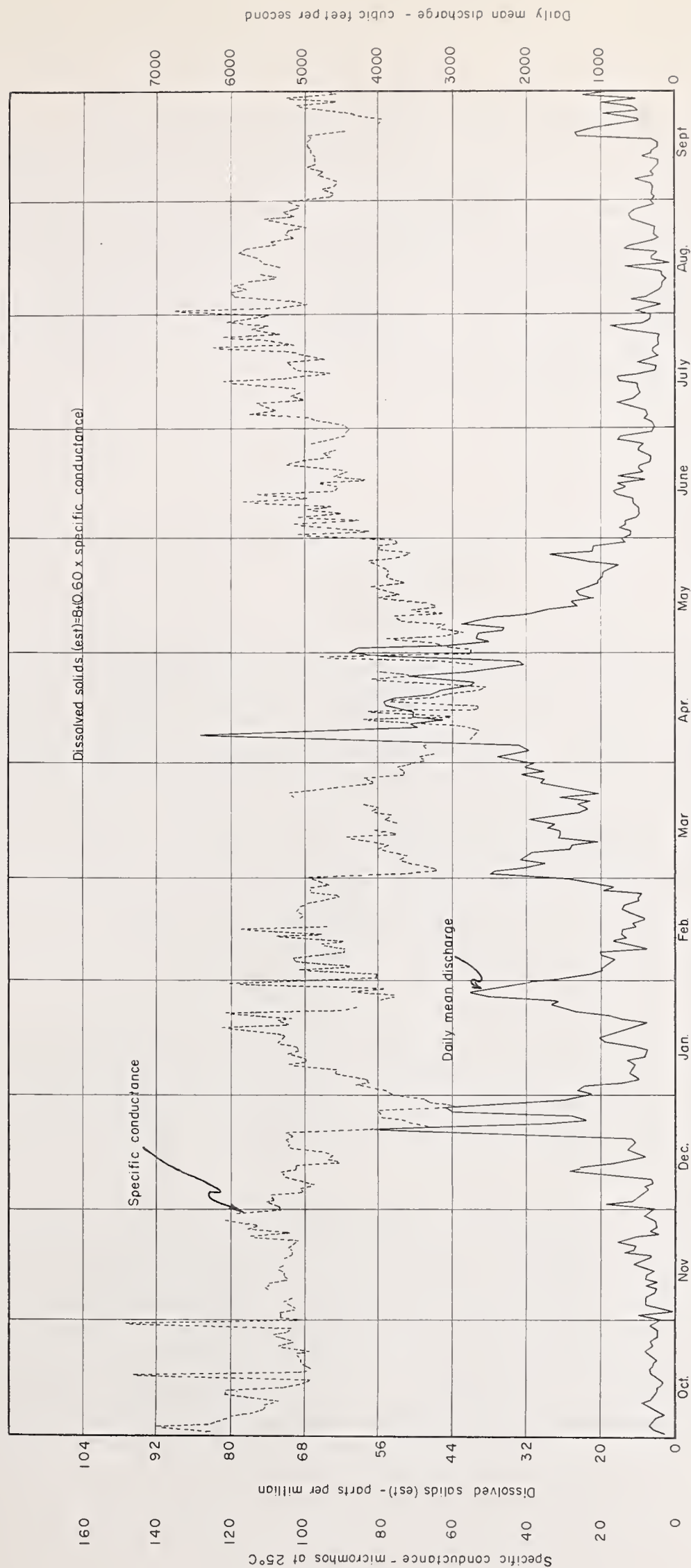


Figure 2.~ Specific conductance and daily mean discharge, Farmington River at Rainbow, 1957-58

unlimited. In the Connecticut River at Thompsonville, concentrations of dissolved solids (based on specific conductance data) decreased rapidly as discharge increased to about 20,000 cubic feet per second (cfs). They decreased gradually thereafter as discharge rose 40,000 cfs, and then remained comparatively stable (fig. 13). For smaller streams the initial decrease in the concentrations of dissolved solids may be more abrupt. Then, too, the concentrations of dissolved solids become relatively stable.

Ground Water

A preliminary evaluation shows that much of the ground water in the basin is of good quality. Concentrations of dissolved solids ranged from 36 to 285 ppm and hardness ranged from 16 to 132 ppm. These ranges should not be regarded as representative for the entire basin but more as indices. However, the ranges do illustrate differences in the quality of waters from different formations. Water from a well in sand and gravel contained 285 ppm of dissolved solids whereas water from till contained only 44 ppm of dissolved solids. Hardness was highest in water obtained from basalt and lowest in water from sand and gravel.

Such differences in quality of water can also be expected from one site to another, even within a formation, because of mineral composition, recharge and discharge characteristics, and possible contamination--especially in shallow wells.

Perhaps the greatest range in concentration of dissolved solids can be expected in water from sand and gravel. Based on available data, the range of dissolved solids extended from 48 to 285 ppm and hardness from 22 to 132 ppm. What the composition of water might be from a given well would be difficult to predict. Generally, the chemical composition consisted principally of calcium, sodium, bicarbonate, sulfate

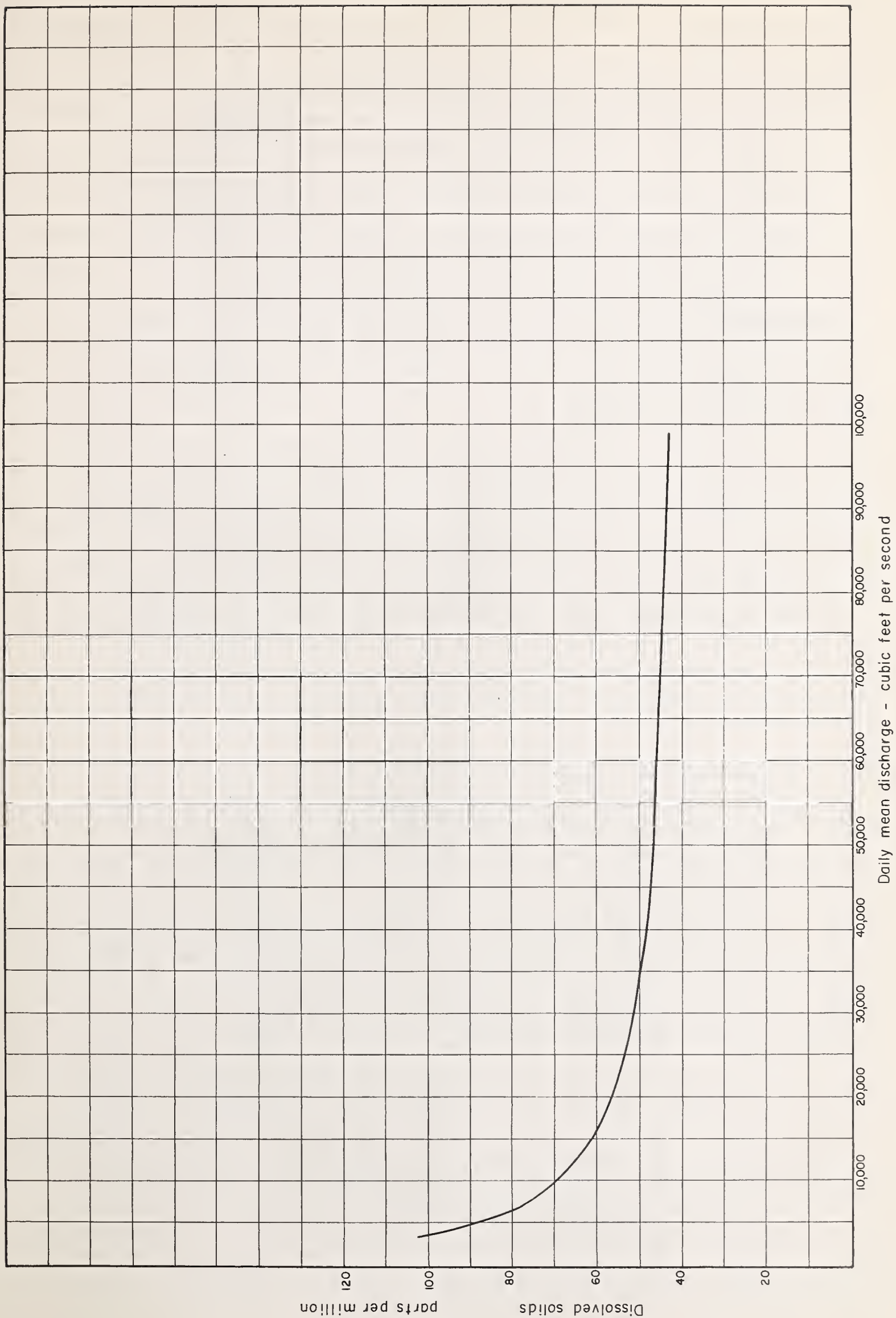


Figure 13:- Relationship between dissolved solids and discharge, Connecticut River at Thompsonville, 1955-56

and nitrate. Various concentrations and combinations of these constituents were determined in the wells examined (table 10 and 11). Nitrate concentrations as high as 86 ppm were determined in water from several shallow wells and are believed to have resulted from surface contamination. Surprisingly, iron concentrations exceed 0.3 ppm in only 3 wells of the 28 wells sampled. Usually, manganese concentrations (also a troublesome constituent in water if concentrations are about 0.3 ppm) were less than 0.1 ppm. The high concentrations of 0.97 ppm in water from well EW 57 and 0.60 ppm from well GR 145 are unusual. Further investigation is necessary to determine the areal distribution of manganese in water from sand and gravel deposits.

Water from sandstone and crystalline rock had a narrower range of dissolved solids and hardness - 58 to 167 ppm and 33 to 104 ppm respectively. The chemical composition was more uniform - principally calcium and bicarbonate. Water from several wells contain iron concentrations as high as 1.1 ppm. Such concentrations would present a problem of iron removal. Except for iron, the chemical quality of water from sandstone and crystalline rock was good. However, additional data are needed to determine if this classification can be applied generally to water from sandstone and crystalline-rock aquifers in the basin.

The chemical quality of water from basalt was about the same as that from crystalline rock. In one sample the dissolved solids concentration was 184 ppm and the hardness was 132 ppm. These concentrations were higher than those determined in water from crystalline rock.

Till is of lesser importance as a water-bearing formation because of its low yield. However, the chemical quality of water was better than that from any other formation in the basin. Additional data are needed to adequately appraise the chemical quality of water obtained from till.

Well Number	Date of collection	Water temperature (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
																Calcium, magnesium	Non-carbonate			
9-268 j																				
Chemical analyses in parts per million																				
Sand and Gravel Aquifers																				
A-81	Jan. 5, 1956	50	14	0.26	0.00	25	3.1	3.4	0.5	74	18	3.8	0.0	0.6	108	75	15	172	7.8	3
B1-49	Mar. 30, 1954	55	16	.10	.01	20	13	16	1.0	135	27	1.9	.3	.4	156	103	0	250	7.9	2
B1-19	May 21, 1953	--	9.4	.11	.06	12	1.3	8.6		40	14	2.1	.1	3.5	71	35	3	97.3	7.4	3
Es-78	Sept. 23,1957	54	24	.08	.01	9.6	3.3	7.1	2.6	36	11	7.3	.2	5.7	86	38	8	117	6.0	3
EH-1	May 18, 1953	57	14	.06	.13	21	3.9	28		3.0	58	48	.5	7.0	204	68	66	332	5.0	10
EH-37	May 18, 1953	57	9.3	.06	.13	30	5.6	56		125	87	18	.3	.2	285	98	0	442	8.1	15
EH-42	Mar. 26, 1954	47	9.4	.25	.02	25	6.6	9.4	8.2	15	50	7.9	.1	.63	201	90	77	268	6.2	3
EW-6	May 27, 1953	50	16	.20	.10	30	5.7	55		187	57	3.9	.2	.3	262	98	0	404	7.8	2
EW-10	May 27, 1953	52	12	.09	.04	22	2.6	65		180	53	2.8	.2	.1	249	66	0	385	7.9	2
EW-49	May 27, 1953	50	9.9	.08	.00	21	4.3	29		142	12	2.4	.3	.9	163	70	0	261	7.7	2
EW-57	Apr. 4, 1954	48	12	.42	.97	28	6.8	5.9	.8	41	43	5.9	.0	.33	167	98	64	237	7.0	5
EW-58	Mar. 30, 1954	43	6.5	.09	.05	18	2.4	13	11	12	46	9.9	.0	.43	138	55	45	210	6.5	2
EW-59	Mar. 30, 1954	49	7.8	.28	.02	7.4	2.5	2.1	4.8	3.8	32	1.9	.1	1.8	67	29	26	96.7	5.4	2
EW-60	Mar. 30, 1954	43	3.5	.15	.01	13	2.0	3.6	2.0	5.0	31	4.7	.1	9.5	79	41	37	118	6.0	2
F-3	May 1, 1956	52	14	.17	.01	22	1.6	2.7	.7	69	7.7	3.2	.0	.2	86	62	5	129	8.1	2
F-6	Jan. 2, 1956	54	12	.33	.00	21	2.3	3.5	.7	51	11	6.0	.0	8.8	97	62	20	149	6.6	3
G1-103	May 26, 1954	--	9.4	.06	.00	7.6	1.6	2.8	1.5	17	18	2.2	.0	3.2	52	26	12	70.7	6.6	5
G1-104	Mar. 26, 1954	50	14	.41	.01	10	2.3	11	3.4	15	20	18	.0	9.0	101	34	22	144	6.1	3
Or-82	Jan. 2, 1956	50	9.8	.08	.01	4.8	1.1	2.0	.4	14	8.6	1.6	.0	.5	36	16	5	50.7	7.1	2
Or-90	Jan. 2, 1956	52	12	.05	.00	43	2.2	9.7	.6	61	69	10	.1	1.3	191	116	66	294	7.2	2
Or-145	May 8, 1956	--	7.8	.33	.60	8.1	2.0	2.9	.7	36	2.6	3.6	.0	.1	46	28	0	69.2	6.7	7
M-46	Apr. 5, 1954	49	13	.14	.00	15	3.0	5.0	1.0	33	27	3.8	.0	3.5	98	50	23	137	6.6	3

Table 10.--CHEMICAL ANALYSES OF WATER FROM WELLS IN CONNECTICUT RIVER BASIN--Continued

Chemical analyses in parts per million--Continued																				
Well Number	Date of collection	Water temperature (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
																Calcium, magnesium	Non-carbonate			
Sand and Gravel Aquifers--Continued																				
M-57	July 20, 1954	57	15	0.02	0.03	35	9.1	8.7	0.6	16	57	4.0	0.0	86	258	125	112	317	6.3	2
M-58	Apr. 5, 1954	48	17	.21	.01	33	2.7	6.3	.7	90	21	5.0	.1	12	144	93	20	212	7.9	2
P-66	May 18, 1953	50	11	.06	.00	22	2.0	3.8	.7	68	16	1.8	.0	1.4	119	63	8	147	8.0	6
S-8	Sept. 23, 1957	55	13	.08	.05	3.5	1.2	2.8	.4	8	6.8	2.5	.1	2.8	38	14	7	43	6.8	2
S-144	Sept. 23, 1957	51	22	.16	.00	26	5.2	3.8	.6	79	16	4.2	.1	9.5	123	87	22	187	7.6	2
SI-75	Jan. 2, 1956	50	12	.10	.01	3.4	1.5	2.5	.4	13	2.3	2.6	.0	3.1	41	15	4	46.7	6.4	2
So-12	May 26, 1953	50	16	.01	.02	25	5.3		7.1	37	46	10	.1	8.8	143	84	54	225	7.1	5
So-61	May 26, 1953	48	12	.55	.03	21	3.4		9.5	17	18	19	.1	34	133	66	53	233	6.0	5
SW-68	May 20, 1953	49	9.6	.13	.08	16	5.1		14	26	50	9.0	.3	9.0	140	61	40	192	5.6	10
SW-69	May 20, 1953	51	12	.24	.06	8.2	3.0		4.1	15	19	5.0	.0	4.0	77	33	21	104	6.1	10
SW-71	July 20, 1954	51	15	.02	.00	42	6.6	9.1	.6	28	74	3.5	.0	62	259	132	109	324	6.7	2
SW-72	Mar. 27, 1954	49	8.6	.01	.00	15	4.3	6.7	4.0	9.0	46	8.2	.0	11	114	55	48	165	6.4	5
SW-73	Mar. 27, 1954	45	12	.18	.02	5.6	2.0	3.3	1.3	6.0	18	.7	.1	7.5	63	22	17	71.7	6.1	2
W-9	Mar. 30, 1954	43	4.0	.09	.02	4.6	1.1	3.8	1.3	3.4	18	3.2	.1	2.5	48	16	13	60.6	5.5	3
W-11	May 27, 1953	50	8.7	.03	.01	26	3.8		8.3	63	27	4.1	.1	16	147	81	29	212	7.0	5
WL-3	Apr. 15, 1954	49	9.2	.13	.00	25	6.4	9.0	1.5	60	47	3.4	.0	6.0	137	89	40	213	7.8	2
WL-4	Apr. 15, 1954	50	9.2	.12	.00	16	5.8	3.4	1.3	42	31	3.2	.0	5.5	104	64	29	147	7.3	0
WL-10	July 20, 1954	52	9.5	.01	.03	15	6.8	2.0	.5	61	13	2.8	.0	5.0	88	65	15	138	7.5	2
Crystalline Bedrock																				
A-68	Jan. 7, 1956	51	10	.21	.04	5.7	1.6	2.2	.4	23	6.4	1.7	.0	.0	42	21	2	58.1	6.4	3
Fs-46	Sept. 23, 1957	53	27	.06	.01	17	7.8	6.7	1.4	76	11	9.8	.1	4.7	119	75	12	179	6.9	2
EI-28	May 20, 1953	52	14	.09	.03	8.6	2.8		6.9	32	18	2.0	.1	.5	69	33	7	90.0	6.9	5

Table 10.--CHEMICAL ANALYSES OF WATER FROM WELLS IN CONNECTICUT RIVER BASIN--Continued

Well Number	Date of collection	Water temperature (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
																Calcium, magnesium	Non-carbonate			
9-268 j																				
Chemical analyses in parts per million--Continued																				
Crystalline Bedrock--Continued																				
Gl-76	Mar. 30, 1954	55	15	0.39	0.01	6.3	1.3	3.6	1.7	26	8.0	0.9	0.1	0.8	58	21	0	64.0	6.9	3
Gl-46	May 18, 1953	56	13	.06	.03	30	4.0	11		69	34	10	.0	12	157	91	35	248	6.9	5
Mt-262	June 28, 1956	58	14	3.6	.22	10	2.1	3.8	.9	25	18	2.6	.3	.1	64	34	13	92.5	6.7	8
Mt-266	June 29, 1956	60	14	.51	.06	25	6.3	16	1.6	136	9.4	2.0	1.1	.1	137	88	0	234	7.7	3
Mt-275	June 29, 1956	52	11	--	--	7.4	.6	32	1.7	96	6.7	2.3	1.1	.2	111	21	0	176	7.2	3
Mt-285	June 28, 1956	50	24	1.4	.25	24	2.2	4.8	2.0	82	12	2.4	.5	.2	115	69	2	170	7.1	4
P-36	June 2, 1953	52	12	.06	.02	33	5.3	11		100	17	10	.0	16	167	104	22	262	7.7	7
S-76	Sept. 23, 1957	52	8.7	.60	.05	13	4.2	4.2	2.0	47	9.5	2.8	.1	8.2	77	50	12	125	6.7	2
Si-59a	Jan. 1, 1956	51	12	.79	.16	8.5	1.9	2.1	.6	29	10	1.6	.1	.1	52	29	5	75.5	6.3	2
So-24	May 26, 1953	52	3.6	.34	.09	20	2.6		9.6	46	39	3.2	.1	.3	110	61	23	175	7.2	2
V-8	May 20, 1953	52	23	.02	.12	20	2.6		1.7	56	10	4.5	.3	2.2	107	61	15	161	7.4	5
V-47	May 20, 1953	54	11	1.1	.16	7.0	3.1	4.2		22	18	6.0	.1	2.4	63	30	12	106	6.3	10
Sedimentary																				
A-62	Jan. 7, 1956	54	13	.04	.00	19	1.8	3.5	.4	54	12	3.1	.0	2.7	86	55	11	131	7.4	3
Bl-32	Mar. 26, 1954	52	17	.24	.00	20	6.8	12	1.1	80	26	3.9	.0	12	145	78	12	201	7.8	7
F-16	Jan. 5, 1956	55	24	.36	.01	26	9.3	6.0	.5	89	20	14	.0	2.8	159	103	30	242	6.9	2
F-78	Jan. 7, 1956	51	16	.20	.01	17	1.3	20	.8	78	20	5.2	.0	2.0	124	48	0	184	7.7	21
Gr-26	Jan. 5, 1956	54	12	.11	.00	8.1	1.1	39	.6	a 99	18	4.7	.7	2.4	134	25	0	209	8.9	3
Mf-164	May 16, 1953	52	15	.08	.01	18	2.4	4.8	.4	42	23	1.3	.1	5.0	126	55	20	135	7.4	7
Pv-19	Sept. 23, 1957	55	20	.04	.00	35	16	10	1.4	175	24	5.7	.2	6.1	204	154	10	336	8.1	3
S-130	Sept. 23, 1957	50	24	.22	.00	35	6.8	5.5	3.6	108	28	4.1	.1	5.7	164	116	28	257	6.8	2
S-256	Sept. 23, 1957	52	5.5	1.2	.03	16	1.7	8.1	.2	69	4.7	3.4	.1	.5	73	47	0	126	7.7	2

Table 10.--CHEMICAL ANALYSES OF WATER FROM WELLS IN CONNECTICUT RIVER BASIN--Continued

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Chemical analyses in parts per million--Continued

Well Number	Date of collection	Water temperature (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
																Calcium, magnesium	Non-carbonate			
B1-27 B1-31 Gr-88 F-20 Mf-165	May 21, 1953	53	19	0.13	0.03	27	3.5	8.0		69	30	6.6	0.3	4.0	154	82	25	202	7.2	2
	May 27, 1953	49	11	.10	.03	28	15	7.8		112	27	6.8	.0	24	184	132	40	312	7.4	3
	Apr. 3, 1954	--	19	.16	.00	21	5.4	7.8	3.0	64	26	7.1	.1	7.9	140	75	22	197	7.1	0
	Jan. 2, 1956	54	13	.16	.00	31	5.3	3.7	.6	116	9.6	4.0	.0	.0	131	99	4	209	8.0	4
	May 16, 1953	51	19	.07	.00	25	4.5	4.6	.2	89	18	.4	.0	.4	124	81	8	179	7.9	3
Ground Moraine																				
E1-22	May 20, 1953	52	6.8	.84	.08	5.5	3.0	3.2		9.0	21	2.5	.1	.5	58	26	19	80.6	6.1	10
E1-27	May 20, 1953	47	8.7	2.0	.02	4.2	2.8	1.5		20	7.2	1.5	.1	.5	44	22	6	53.5	6.5	20

Includes equivalent of 10 parts per million of carbonate (CO₃)

n Includes equivalent of 10 parts per million of carbonate (CO₃)

Table 11. -- DATA OF WELLS IN THE CONNECTICUT RIVER BASIN

Well No.	Depth (feet)	Diam. (in.)	Water bearing formation	Yield gpm	Owner Location
A-62	87	6	Sedimentary	15	J. J. Maher, Arch Rd., 3200' W. of College Highway, Avon, Conn.
A-68	101	6	Crystalline bedrock	4±	Elmer Pennala, Chevas Rd., Avon, Conn. (1000' W. of Lovely St.)
A-81	82	6	Sand and gravel	8	Chester R. Woodford, Nod Rd., 1 mi. N. of Rt. 44, nr Avon, Conn.
B1-19	47	4	Sand and gravel	20	N. Nigro, Newberry Rd., Bloomfield 2-1/2 mi. N. E. of Bloomfield, Conn.
B1-27	210	6	Basalt	20	Mrs. R. D. Shaw, Duncaster Rd., Bloomfield, 2-1/2 mi. N. W. of Bloomfield, Conn.
B1-31	96	6	Basalt	12	E. Case, 262 Duncaster Rd., Bloomfield, 2 mi. N. W. of Bloomfield, Conn.
B1-32	609	10-8	Sedimentary	340	Conn. General Life Insurance Co., Hartford, Conn., 1 mi. So. of Bloomfield, Conn.
B1-49	66	--	Sand and gravel	--	R. Kohler, 320 Woodland Ave., Bloomfield, Conn.
Bs-46	255	6	Crystalline bedrock	5	L. D. Minor, Hill St., Bristol, Conn.
Bs-78	7.5	36	Sand and gravel	--	L. A. Dodd, Old Waterbury Rd., Bristol, Conn.
Cr-88	66	6	Basalt	6±	D. DeMers, at corner North Rd. and Christian Hill Rd., Cromwell, Conn.
EH-1	32	8	Sand and gravel	80	First National Stores Inc., Park Ave., East Hartford, Conn.
EH-37	258	8	Sand and gravel	500	First National Stores Inc., Park Ave., East Hartford, Conn.
EH-42	26	36	Sand and gravel	30	Robert DePietro, Forest St., East Hartford, Conn., 2-1/2 mi. ESE of East Hartford, Conn.
E1-22	21	30	Ground Moraine	--	Henry Aberle, Shenipsit Rd. Ellington, 2 mi. S. E. of Ellington, Conn.
E1-27	28	24	Ground Moraine	3	P. M. Hansen, Cider Mill Rd., Ellington, 2 mi. E. of Ellington, Conn.
E1-28	92	8	Crystalline bedrock	8	C. O. Peterson, RFD #1, Ellington, Conn., 2-1/2 mi. S. E. of Ellington, Conn.
EW-6	198	6	Sand and gravel	20	E. Woolam, Warehouse Pt., 2-1/2 mi. S. W. of Broad Brook, Conn.
EW-10	160	6	Sand and gravel	30	L. Stoughton, Warehouse Pt., 3-1/4 mi. N. W. of Broad Brook, Conn.
EW-49	85	6	Sand and gravel	7	Bass Bros., Warehouse Pt., 2 mi. E. of Warehouse Pt., Conn.
EW-57	6	2	Sand and gravel	3	Joseph Reichle, Broad Brook, 0.6 mi. SW of Broad Brook, Conn.
EW-58	12-1/2	36	Sand and gravel	--	Stephan Haydusk, Windsorville, Conn.
EW-59	9	36	Sand and gravel	--	R. Miercier, 140 Phelps Rd., Warehouse Pt., Conn.
EW-60	10	36	Sand and gravel	--	Henry Kolodziej, Broad Brook, Conn., E. Windsor (Wells Rd)
F-3	120	6-8	Sand and gravel	30	T. E. Stephenson, Town Farm Rd., 1 mi. NE Farmington, Conn.
F-6	37	6	Sand and gravel	25	Herbert Shirley, Farmington Ave. W. of R. R., Farmington (Rt. 4) Conn.
F-16	55	6	Sedimentary	8	R. A. Weisner, Wolf Pit Rd., 250' W. of Birdseye Rd., Farmington Ctr. (1 mi E), Conn.
F-20	353	6	Basalt	5	W. W. Fisher, Old Mtn. Rd., 2 mi. N. of Farmington, Conn.
F-78	438	8	Sedimentary	40	Gross-Itte and Whitman Mfg. Co's., nr. Farmington, Conn.
G1-46	210	6	Crystalline bedrock	6	Louis Scaglia, 409 Hopewell Rd., So. Glastonbury, 2 mi. S. E. of So. Glastonbury, Conn.
G1-76	353	6	Crystalline bedrock	3/4	Renato Massa, 85 Quarry Rd. E. of Rt. 2, Glastonbury, Conn.
G1-103	52	2	Sand and gravel	15	S. N. Aiello, 54 Pond Circle, 3 mi. E. Glastonbury, Conn.
G1-104	23	24	Sand and gravel	3±	Ray Dailey, New London Tpke., 4 mi SE of Glastonbury, Conn.
Gr-26	328	6	Sedimentary	6-1/2	R. E. Case, W. Granby PO, nr W. Granby, Conn.
Gr-82	53	6	Sand and gravel	30	G. S. Fogarty, Quarry Rd. at Zimmer Rd., N. of Granby, Conn.

Table 11. --DATA OF WELLS IN THE CONNECTICUT RIVER BASIN--Continued

Well No.	Depth (feet)	Diam. (in.)	Water bearing formation	Yield gpm	Owner Location
Gr-90	65	6	Sand and gravel	5	D. R. Schively, Notch Rd. 2 mi. north of Granby, Conn.
Gr-145	140	6	Sand and gravel	3	W. Smiley, College hiway, N. Granby, Conn.
M-46	60	10	Sand and gravel	750	City of Manchester Water Department, Manchester, Conn.
M-57	52	12	Sand and gravel	250	Hartman Tobacco Co., 2 mi. NW of Manchester, Conn.
M-58	64	12	Sand and gravel	450	City of Manchester Water Dept. (Love Lane) Manchester, Conn.
Mf-164	135	6	Sedimentary	50	Arthur Meckley, RFD, Rockfall, Conn. 1 mi. east of Middlefield, Conn.
Mf-165	66	6	Basalt	12	George Cunningham, Lake Beseck, Middlefield, 1-1/2 mi. west of Middlefield, Conn.
Mt-262	67	6	Crystalline bedrock	1/4	AEC Hartford Research Center, River Rd. 0.3 mi. NW of Auto Shop at CANEL, Middletown, Conn.
Mt-266	309	6	Crystalline bedrock	--	J. C. Muller, R. D. # 2, Middletown, Conn. (on River Rd. 0.5 mi. S. of CANEL)
Mt-275	140	6	Crystalline bedrock	--	J. C. Muller, Rt. 2, Middletown, Conn. (at jct. River Rd. & Maromas Rd. 0.7 mi. S. of CANEL)
Mt-285	51	6	Crystalline bedrock	2	AEC Hartford Res. Center (River Rd. 500' SW Auto Shop at CANEL) Middletown, Conn.
P-36	283	6	Crystalline bedrock	17	R. Wetzel, Penfield Hill, 3 mi. E. of Portland, Conn.
P-66	146	6	Sand and gravel	15	John Harper, Ames Hollow Rd., 2 mi. east of Portland, Conn.
Pv-19	220	6	Sedimentary	5-7	Walter Sullivan, Pinnacle Rock Farm, Plainville, Conn.
S-8	22	24	Sand and gravel	--	F. Madin, Prospect St., Southington, Conn.
S-76	88	6	Crystalline bedrock	--	Mr. & Mrs. Jacobowsky, DeFashion St. Southington, Conn.
S-130	202	6	Sedimentary	--	John Welch, Flanders Rd., Southington, Conn.
S-144	140	6	Sand and gravel	14	Ralph Mongillo, Woodruff St., Southington, Conn.
S-256	100	6	Sedimentary	--	Andrew Hubeny, Burritt St., Southington, Conn.
Si-59a	301	8	Crystalline bedrock	10-14	F. H. Andrus estate W. of W. Ledge Rd., near W. Simsbury, Conn.
Si-75	55	2	Sand and gravel	5	Ingvald Ollestad, 45 Wildwood Rd., Weatogue, Conn.
So-24	135	6	Crystalline bedrock	4-1/2	C. Bridge, 1-1/2 mi. S. E. of Somers, Conn.
So-42	13	1-1/2	Sand and gravel	--	M. McGuinness, Thomas Rd., 1 mi. N. W. of Somers, Conn.
So-61	28	1-1/2	Sand and gravel	--	S. Kismn, Bryant Rd., 2-1/2 mi. N. W. of Somers, Conn.
SW-68	9	24	Sand and gravel	--	P. P. Bielski, E. Windsor Hill, 1-1/2 mi. E. of Windsor Hill, Conn.
SW-69	30	24	Sand and gravel	--	J. A. Dupont, Burnham St., So. Windsor, 2 mi. S. E. of So. Windsor, Conn.
SW-71	56	12	Sand and gravel	400	Kupchunos Bros. 2 mi. NW of Wapping, Conn.
SW-72	30	108 to 72	Sand and gravel	--	Peter Yonika, Strong Rd., 0.6 mi. SE of E. Windsor Hill, So. Windsor, Conn.
SW-73	30	30	Sand and gravel	4-5	H. L. Belknap, Wapping, Conn., (Barbour Hill Rd.) 3/4 mi. E. of E. Windsor, Conn.
V-8	150	6	Crystalline bedrock	5	Frank Bronkie, Lake St., Vernon, 1-1/2 mi. S. of Vernon, Conn.
V-47	57	6	Crystalline bedrock	10	John Rogers, RFD, Vernon, 3/4 mi. S. W. of Vernon, Conn.
W-9	9	36	Sand and gravel	--	Mrs. M. Jorozko, Dudley Town Rd., Windsor, Conn., (Dudley Town Rd) 2.2 mi. WSW of Windsor, Conn.
W-11	20	36	Sand and gravel	--	H. Barber, Windsor, Conn., 3-1/2 mi. No. of Windsor, Conn.
WL-3	80	10	Sand and gravel	300	Bradley Field, Windsor Locks, Conn., 2-1/2 mi. W. of Windsor Locks, Conn.
WL-4	32	8	Sand and gravel	125	Bradley Fld., Conn., 2-1/2 mi. W. of Windsor Locks, Conn.
WL10	68	8	Sand and gravel	300	Robert Rodelli, Elm St., Windsor Locks, Conn., 1-1/2 mi. SW of Windsor Locks, Conn.

Summary

Flowing through the central lowland, the Connecticut River and its tributaries drain an area of sandstone, shale, basalt and crystalline rock overlain by unconsolidated deposits of sand, gravel and till. The mineral matter is moderately soluble. This is reflected in the solute content of the major streams. Concentrations of dissolved solids ranged from 40 to 90 ppm. In the smaller streams the concentrations of dissolved solids were much higher. Most streams are polluted in varying degree. Although the increase in mineral content from industrial wastes is undetermined, the mineral content of major streams does not appear excessive. Streamflow is a moderating influence. Some of the smaller streams have higher concentrations that may be attributable to pollution. Generally, the chemical quality of surface waters in the Connecticut River basin range from good to fair.

Ground water is obtained from bedrock and unconsolidated water-bearing formations. However, with the exception of till, wells in unconsolidated formations are more productive than those in bedrock. Generally, the chemical quality of water from sand and gravel is good. Concentrations of dissolved solids were 300 ppm or less and, usually the water was soft. Water from several wells contained concentrations of iron and manganese that would be troublesome. Nitrate concentrations were also high in water from several wells.

The chemical quality of water from crystalline rock and sandstone is similar to that in water obtained from sand and gravel. However, a few exceptions have been noted.

Several chemical analyses show that water from till has a very low dissolved solids content and is very soft. Unfortunately, the yield of water from till is very small.

QUINNIPIAC RIVER BASIN

Surface Waters

The chemical composition of the Quinnipiac River is similar to that of the Connecticut and Farmington Rivers - principally calcium and bicarbonate. This would be expected because all streams in the central region drain an area of sandstone overlain by sand and gravel. However, the concentrations of dissolved solids and hardness in the Quinnipiac River fluctuated over a wider range than those for the other major streams (tables 12 & 13). These differences in quantity rather than kind of material in solution are attributed to the greater dilution potential of major streams such as the Connecticut and Farmington Rivers.

The range in dissolved solids determined for composites of water samples collected daily from the Quinnipiac River was comparatively narrow - 103 to 174 ppm. Daily specific conductances indicate, however, that concentrations of dissolved solids fluctuated over a wider range (fig. 14).

During high flow, dilution reduced the concentrations of solutes in the Quinnipiac River at Wallingford. On April 20, 1954 when daily mean discharge was 390 cfs, concentrations of dissolved solids were reduced to 84 ppm and hardness to 43 ppm. During the period April 6 - 10, 1957, streamflow averaged 699 cfs and concentrations of dissolved solids (estimated) were 78 ppm, and hardness was 46 ppm. These concentrations are similar to those determined for the Connecticut and Farmington Rivers. Whether the solute content would be reduced even more with higher discharges is not known. However, it is believed that the chemical quality of the major streams in the central region is similar. Apparent differences in concentrations of solute material are attributable to the greater dilution potential of the Connecticut and Farmington Rivers in comparison to that of the Quinnipiac.

Table 12. -RANGE OF DISSOLVED SOLIDS, HARDNESS
AND AVERAGE DISCHARGE OF MAJOR
RIVERS IN CENTRAL CONNECTICUT

Stream and Location	Period	Range of concentration (ppm)		Average Discharge (cfs)
		Dissolved Solids	Hardness	
Connecticut River at Thompsonville	1955-56	46-91	24-53	16,640 (28 yrs.)
Farmington River at Rainbow	1957-58	43-80	20-60	1,099 (28 yrs.)
Quinnipiac River at Wallingford	1956-57	103-174	46-95	210 (26 yrs.)

Table 13. --SUMMARY OF CHEMICAL DATA,
QUINNIPIAC RIVER AT WALLINGFORD

October 1956 - September 1957

a Constituent	Minimum	bAverage	Maximum
Silica (SiO ₂)	9.8	13	24
Iron (Fe)	.12	.29	.54
Calcium (Ca)	16	23	28
Magnesium (Mg)	3.6	4.7	6.4
Sodium (Na)	6.8	10	14
Potassium (K)	1.2	2.0	2.7
Bicarbonate (HCO ₃)	32	68	110
Sulfate (SO ₄)	16	24	29
Chloride (Cl)	6.5	9.6	13
Fluoride (F)	.0	.1	.2
Nitrate (NO ₃)	3.2	8.5	15
Dissolved solids	103	135	174
Hardness as CaCO ₃ (calcium&magnesium)	c 46	77	95
Specific conductance (micromhos at 25°C)	123	214	257
pH	6.6	--	7.1
Color	2	7	15
Oxygen Consumed, unfiltered samples	3	5	11
Oxygen Consumed, filtered samples	2	4	6

a. In parts per million except pH, color and specific conductance

b. Time-weighted

c. By complexometric titration

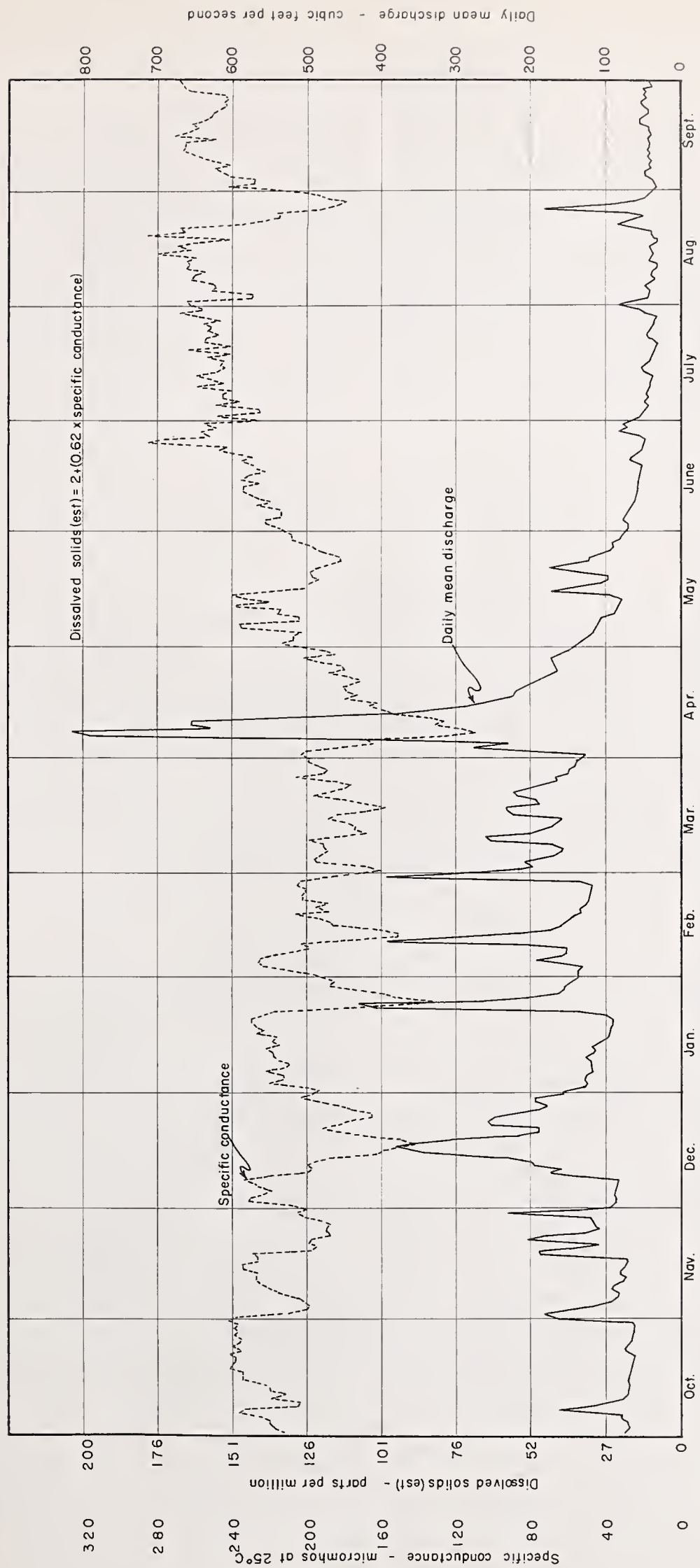


Figure 14.- Specific conductance and daily mean discharge, Quinipiac River at Wallingford, 1956 - 57

Summary

A complete definition of the chemical quality of water resources in the Quinnipiac River basin cannot be made at this time. Data are available only for the main stem at Wallingford. There the Quinnipiac contained moderate concentrations of dissolved solids and was moderately hard. The concentrations were usually higher than those in other rivers in the central part of the State. The chemical quality of ground water has not been appraised.

THAMES RIVER BASIN

Surface Waters

The chemical quality of surface waters in the Thames River basin was generally as good or better than the chemical quality of surface waters in other basins throughout the State. The waters contained less dissolved solids and were softer. There were some differences in chemical composition, but these were more apparent in the concentrations of the individual constituents and their relation to one another. These characteristics evolve from the interaction of geology, streamflow, and to a lesser extent stream pollution.

Located in the eastern highlands, streams in the basin drain an area of crystalline rock overlain with unconsolidated sand and gravel. Because of the relatively low solubility of crystalline rocks only small quantities of mineral matter are dissolved. Granite typically is composed of silica, sodium, potassium, calcium, aluminum, and probably contain some iron. The unconsolidated deposits are believed to be similar in mineral composition and solubility to the granitic rocks from which they largely were derived. These geologic characteristics are reflected in the comparatively lower mineral content of surface waters in the basin than that present in surface waters in other basins in the State. Concentrations of dissolved solids as low as 26 ppm and hardness as low as 10 ppm have been determined for some surface waters (tables 14 and 15).

Table 14. ---PERIODIC ANALYSES OF STREAMS IN CONNECTICUT

THAMES RIVER BASIN

Source and Location	Date of Collection	Instantaneous Discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
															Calcium	Non-carbonate			
Quinebaug River at Jewett City, Conn.	7-8-57	b135	2.2	0.12	7.4	2.1	15	2.2	40	17	8.2	0.2	2.5	90	27	0	136	6.9	15
	7-15-57	b112	4.5	.26	7.2	.7	14	1.9	34	14	7.1	.1	2.3	76	21	0	114	6.5	13
	7-29-57	b116	3.5	.22	8.1	1.0	11	1.9	32	12	8.1	.1	2.5	71	24	0	109	6.5	12
	8-6-57	b112	3.0	.21	7.1	.8	16	2.1	39	14	8.0	.1	2.6	82	21	0	126	6.6	12
	8-12-57	b 79	3.6	.18	6.9	.6	16	2.2	38	15	7.9	.2	2.4	83	20	0	131	6.5	10
	8-26-57	b154	2.8	.18	7.4	1.6	20	2.5	44	18	10	.1	3.1	92	25	0	155	6.6	15
	9-5-57	b129	3.8	.21	8.2	1.5	22	2.8	46	19	12	.2	2.6	97	27	0	157	6.7	15
	10-1-57	84	2.0	.05	7.6	1.1	22	2.8	46	18	13	.2	3.1	96	24	0	162	6.5	14
	5-4-56	250	3.9	.14	2.5	1.0	2.0	.6	7	6.1	2.6	.1	.3	26	al0	5	36	6.3	7
	10-5-54	109	8.7	.56	2.7	1.1	3.3	1.0	10	4.1	3.2	.2	1.1	52	al2	3	53	6.8	43
	4-27-55	306	2.8	.07	2.4	.6	2.8	1.0	7	5.2	3.2	.1	1.8	32	al0	4	44	6.2	40
	5-4-56	240	4.2	.16	2.7	1.6	2.4	.6	8	7.3	3.2	.1	.6	49	al3	7	40	6.2	17
	10-1-57	12	5.7	.32	5.1	.6	5.3	3.0	19	3.5	6.0	.1	2.0	54	15	0	72	5.9	9
	11-4-57	22	8.5	.21	5.4	1.1	4.5	1.7	13	9.0	5.3	.2	.8	54	18	8	65	6.3	15
Five Mile River at Killingly, Conn.	12-10-57	68	8.7	.17	5.8	1.6	4.0	1.3	6	16	5.1	.2	1.4	51	21	16	72	5.6	10
	1-7-58	126	8.3	.14	4.0	1.4	3.2	.6	4	10	6.0	.2	1.2	44	16	13	54	6.3	10
	2-10-58	171	7.2	.16	3.2	1.6	3.2	1.0	4	10	4.5	.1	1.5	36	15	11	50	5.6	8
	3-11-58	272	5.6	.07	3.4	1.0	2.8	.7	5	8.0	3.8	.1	.7	33	13	9	40	6.4	7
	4-10-58	419	4.4	.09	3.5	1.0	2.6	.4	4	9.5	3.2	.1	.7	32	13	9	37	6.0	13
	5-12-58	308	4.2	.40	2.8	.9	2.8	1.2	6	7.5	3.2	.2	.5	34	11	6	41	5.5	19
	6-10-58	152	4.7	.29	3.2	1.0	2.9	.8	7	6.3	4.0	.1	.9	32	12	7	42	5.5	20
	7-9-58	124	5.7	.42	3.3	.7	2.8	.8	8	5.3	4.0	.1	1.0	37	11	5	43	6.0	30
	8-12-58	48	5.4	.41	3.4	.9	2.9	.5	10	5.2	4.0	.2	.9	38	12	4	43	6.6	10
	9-11-58	228	6.9	.43	3.6	1.0	3.1	1.0	10	4.3	4.7	.4	.2	39	13	5	45	6.2	25
	5-4-56	77	6.7	.15	3.2	1.8	1.9	.6	12	5.5	2.4	.0	.7	34	al6	6	43	7.1	12
	9-17-53	5.3	8.7	.52	8.0	1.5	20	2.1	36	15	20	.3	.8	103	al7	0	157	6.9	8
	4-20-54	885	5.6	.17	2.8	1.7	2.3	.8	8.0	8.4	2.4	.1	.8	40	al5	8	41	6.2	2
Mooseup River at Moosup, Conn.	10-1-57	5.5	6.3	.07	8.9	1.5	3.5	1.5	22	10	6.0	.1	.7	51	28	10	74	6.2	2
	11-4-57	119	9.0	.14	7.0	1.8	3.8	1.8	19	12	6.0	.1	.7	68	25	10	82	6.3	3
	12-10-57	374	9.2	.23	9.1	2.5	3.4	1.3	10	21	5.6	.0	1.2	67	33	25	94	6.9	7
	1-7-58	240	9.5	.08	5.9	2.0	2.6	.6	7	14	4.5	.1	1.2	51	23	17	68	6.2	15
	2-10-58	240	9.3	.10	4.4	1.8	2.8	.9	8	11	4.6	.0	1.6	43	19	12	57	5.9	7
	3-11-58	540	7.5	.02	4.7	1.2	2.3	.8	7	12	3.8	.1	1.2	38	17	11	47	6.5	8
	4-10-58	1,020	6.4	.09	4.4	1.3	2.2	.4	6	11	3.0	.0	.5	36	17	12	41	6.2	7
	5-12-58	550	6.5	.16	3.6	1.3	2.3	.6	8	8.2	2.9	.0	.2	36	15	8	44	6.1	16
	6-10-58	133	7.5	.25	4.8	1.5	2.8	.9	14	7.0	4.5	.1	.9	41	18	7	54	6.0	17
	7-9-58	112	7.7	.46	5.6	1.9	3.2	1.0	16	7.3	4.0	.1	1.2	45	20	7	59	6.8	14
	8-12-58	40	9.1	.34	5.6	1.9	2.8	1.0	20	7.7	3.0	.2	2.0	50	22	6	63	6.8	9
	9-11-58	108	9.4	.34	6.0	1.8	3.3	1.3	21	4.5	5.0	.2	.2	50	23	6	65	6.6	10
Mount Hope River near Warrenville, Conn.	5-4-56	77	6.7	.15	3.2	1.8	1.9	.6	12	5.5	2.4	.0	.7	34	al6	6	43	7.1	12
	9-17-53	5.3	8.7	.52	8.0	1.5	20	2.1	36	15	20	.3	.8	103	al7	0	157	6.9	8
Mooseup River at Killbuck, Conn.	10-1-57	5.5	6.3	.07	8.9	1.5	3.5	1.5	22	10	6.0	.1	.7	51	28	10	74	6.2	2
	11-4-57	119	9.0	.14	7.0	1.8	3.8	1.8	19	12	6.0	.1	.7	68	25	10	82	6.3	3
	12-10-57	374	9.2	.23	9.1	2.5	3.4	1.3	10	21	5.6	.0	1.2	67	33	25	94	6.9	7
	1-7-58	240	9.5	.08	5.9	2.0	2.6	.6	7	14	4.5	.1	1.2	51	23	17	68	6.2	15
	2-10-58	240	9.3	.10	4.4	1.8	2.8	.9	8	11	4.6	.0	1.6	43	19	12	57	5.9	7
	3-11-58	540	7.5	.02	4.7	1.2	2.3	.8	7	12	3.8	.1	1.2	38	17	11	47	6.5	8
	4-10-58	1,020	6.4	.09	4.4	1.3	2.2	.4	6	11	3.0	.0	.5	36	17	12	41	6.2	7
	5-12-58	550	6.5	.16	3.6	1.3	2.3	.6	8	8.2	2.9	.0	.2	36	15	8	44	6.1	16
	6-10-58	133	7.5	.25	4.8	1.5	2.8	.9	14	7.0	4.5	.1	.9	41	18	7	54	6.0	17
	7-9-58	112	7.7	.46	5.6	1.9	3.2	1.0	16	7.3	4.0	.1	1.2	45	20	7	59	6.8	14
	8-12-58	40	9.1	.34	5.6	1.9	2.8	1.0	20	7.7	3.0	.2	2.0	50	22	6	63	6.8	9
	9-11-58	108	9.4	.34	6.0	1.8	3.3	1.3	21	4.5	5.0	.2	.2	50	23	6	65	6.6	10

Table 14. ---PERIODIC ANALYSES OF STREAMS IN CONNECTICUT--Continued

THAMES RIVER BASIN--Continued

Source and Location	Date of Collection	Instantaneous Discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evaporation at 180°C)	Hardness as CaCO ₃		Specific conductance (micro-mhos at 25°C)	pH	Color
															Calcium magnesium	Non-carbonate			
Hop River near Columbia, Conn.	10-5-54	53	9.0	.38	4.9	1.3	3.7	1.7	12	7.1	7.5	.1	3.5	54	al8	8	64	7.3	30
"	1-27-55	118	5.7	.08	3.6	.9	2.3	.8	7	8.8	3.0	.0	.7	35	al3	8	48	6.2	25
"	5-4-56	225	6.1	.14	3.6	1.2	2.4	.9	11	8.8	2.8	.0	.4	35	al6	7	49	6.2	8
"	10-1-57	4.1	7.6	.07	6.8	1.2	3.2	1.7	12	6.5	5.0	.1	7.4	53	22	12	81	6.0	7
"	1-7-58	102	7.6	.09	6.0	.9	2.8	.7	6	14	4.8	.1	.2	46	19	14	63	6.7	5
"	4-10-58	300	5.8	.07	4.2	1.4	2.9	.6	8	12	3.4	.1	.5	38	17	10	49	6.0	8
"	7-9-58	96	8.3	.27	5.2	.9	2.8	1.1	12	8.2	4.0	.1	.7	49	17	7	55	6.2	33
Little River at Putnam, Conn.	10-2-57	--	8.3	.04	10	1.5	5.2	2.4	28	11	5.9	.1	1.7	65	31	8	102	6.7	3
"	1-7-58	--	8.7	.14	8.5	1.3	3.1	1.6	8	20	5.8	.2	1.4	64	27	20	86	6.3	20
"	4-10-58	--	5.0	.06	5.6	.8	2.5	1.2	7	12	3.6	.1	.9	40	18	12	54	5.9	12
"	7-9-58	--	4.9	.19	8.6	1.4	3.8	1.7	22	11	5.1	.1	.7	57	28	10	79	7.0	10
Yantic River at Yantic, Conn.	10-5-54	87	9.0	.36	4.9	.9	4.0	1.7	16	7.5	4.3	.1	1.4	55	al6	3	64	7.4	33
"	1-27-55	245	5.1	.04	4.6	1.8	2.9	1.1	11	6.5	3.5	.0	1.0	38	al6	7	54	6.8	30
"	10-1-57	6.3	5.7	.04	8.4	1.1	3.9	2.3	20	9.0	7.6	.0	1.4	53	26	9	84	6.6	4
"	11-4-57	54	7.8	.07	9.8	1.1	4.5	2.3	13	21	6.3	.1	.8	78	32	22	103	6.1	17
"	12-10-57	485	7.8	.20	9.3	1.5	3.6	1.8	8	24	5.2	.0	2.8	65	29	23	91	5.6	13
"	1-7-58	115	8.0	.20	6.4	1.3	3.1	1.0	7	14	5.3	.1	1.2	51	22	16	69	6.3	10
"	2-10-58	202	7.1	.14	5.4	.9	3.1	1.3	7	12	5.6	.0	1.6	44	17	12	63	5.8	7
"	3-11-58	255	6.0	.07	5.4	1.6	2.6	.9	6	11	4.7	.1	1.3	38	20	15	51	6.4	7
"	4-10-58	335	6.4	.07	4.4	1.2	2.7	.7	8	12	3.8	.1	.9	36	16	11	48	6.4	10
"	5-12-58	281	4.3	.14	4.3	1.1	2.7	1.0	8	9.0	3.5	.1	.4	37	15	9	48	6.8	22
"	6-10-58	40	6.1	.22	5.2	1.2	3.2	1.3	14	7.8	4.5	.1	1.3	44	18	7	59	6.1	17
"	7-9-58	146	6.7	.30	4.8	.8	2.8	1.1	11	7.5	4.0	.0	1.0	46	16	7	53	6.2	30
"	8-12-58	22	6.1	.29	6.6	.9	3.4	1.3	18	7.5	5.0	.1	1.2	48	20	5	67	6.5	7
"	9-11-58	99	8.0	.31	6.0	1.3	3.5	1.7	17	7.5	5.7	.2	.2	49	21	7	65	6.2	20

a Includes hardness of all polyvalent cations reported

b Daily mean discharge

Table 15.--SUMMARY OF CHEMICAL DATA OF SURFACE WATERS IN THE THAMES RIVER BASIN

Stream and Location	Period	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue on evap- oration at 180°C)	Hardness as CaCO ₃		Specific conduct- ance (micro- mhos at 25°C)	pH	Color	Oxygen consumed	
														Calcium, magnesium	Non- carbon- ate				Unfil- tered	Fil- tered
Willimantic River near South Coventry, Conn.	Oct. 1956 to Sept. 1957	6.1	0.07	3.4	1.1	2.7	0.6	0	4.4	2.8	0.0	0.1	36	14	0	44	4.15	5	4	3
		8.5	.32	5.2	1.6	5.9	1.5	16	11	5.2	.1	2.6	55	20	7	80	--	12	10	6
		12	.61	7.1	2.2	13	3.0	56	14	10	.2	7.3	89	45	22	130	9.0	25	77	63
Shetucket River near Willimantic, Conn.	Oct. 1956 to Sept. 1957	5.4	.04	3.7	.8	3.3	.8	9	8.1	3.6	.0	.7	42	16	0	55	6.1	5	3	3
		8.3	.26	5.8	1.6	6.6	1.6	17	11	7.2	.1	4.1	61	22	8	92	--	13	6	4
		12	.56	8.9	2.5	18	4.1	58	17	21	.2	16	114	61	43	221	8.0	27	18	6
Quinebaug River at Putnam, Conn.	Oct. 1957 to Sept. 1958	1.2	.11	5.6	1.2	4.2	.9	10	12	5.8	.1	.9	46	20	0	68	6.1	5	7	4
		8.2	.41	8.0	1.8	13	1.9	26	22	9.1	.1	3.5	86	28	9	128	--	13	--	--
		16	.61	12	2.9	39	3.9	60	41	17	.3	7.5	162	42	23	251	6.9	28	15	6
Quinebaug River at Jewett City, Conn.	Oct. 1955 to Sept. 1956	2.6	.16	3.1	1.2	3.1	1.0	8	8.3	3.8	.0	.1	37	14	0	52	6.2	5	3.9	2.3
		6.7	.30	4.9	1.8	6.7	1.4	21	11	6.1	.1	1.8	55	20	5	85	--	14	6.3	4.2
		10	.54	7.1	2.2	16	2.5	133	15	15	.2	3.3	82	44	16	264	7.2	30	11	7.3

Dilution by streamflow is also an important factor and is reflected in the fluctuations of dissolved solids in the Quinebaug River at Putnam and Jewett City (figs. 15 & 16).

The part of the mineral content in water from some streams that can be attributed to pollution has not been determined. At times, however, the change in chemical quality indicates pollution. For example, the acid condition of Willimantic River near South Coventry during the period January 7 - 10, 1956 (pH 4.3 to 4.5) was unusual. In contrast, on May 17, 1957 an alkaline condition was present (pH 9.0). These are extreme pH values. Usually, the pH values ranged from 6.0 to 7.0. Generally, the mineral content of streams in the basin for which data are available, does not appear unusually different from what would be expected under natural conditions and the chemical quality compares favorably with that of streams in other basins.

For example, the Quinebaug River is the major river in the basin. At Putnam it has a drainage area of 331 square miles. During the period of October 11 - 31, 1957 the concentration of dissolved solids in a composite of daily water samples was 162 ppm, of hardness 31 ppm, and mean daily discharge was 43 cfs. Although the discharge is much higher than the lowest discharge of record (8 cfs during 1929-56), it does represent streamflow sustained for the most part by ground water inflow and possibly waste effluent. It is assumed that the concentration of dissolved solids is representative of low-flow conditions. Even under these conditions, the chemical quality does not compare unfavorably with that of surface waters in other basins.

During a comparable period, the average concentration of dissolved solids in composites of water samples from the Naugatuck River near Thomaston was 142 ppm and the average hardness was 46 ppm. In composites of water samples from the Farmington River at Rainbow, the average concentration of dissolved solids was 77 ppm and the average hardness 44 ppm.

Data on chemical quality of other streams in the basin are not available for the same period of record as for the Quinebaug River at Putnam (1957-1958). However, under somewhat similar conditions of high and low discharge, the concentrations of dissolved solids did not exceed those for the Putnam station and the minimum concentrations were lower.

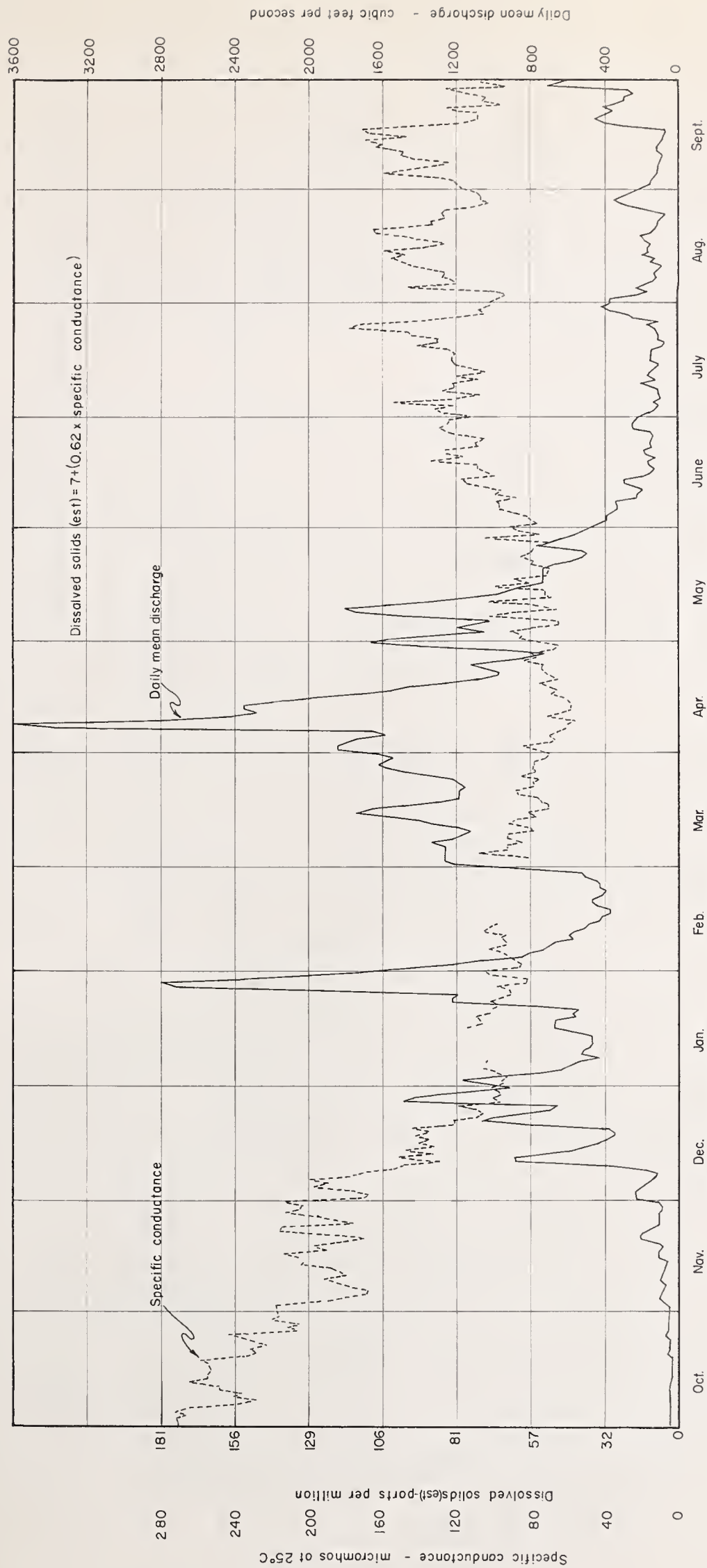


Figure 5.- Specific conductance and daily mean discharge, Quinebaug River at Putnam, 1957 - 58

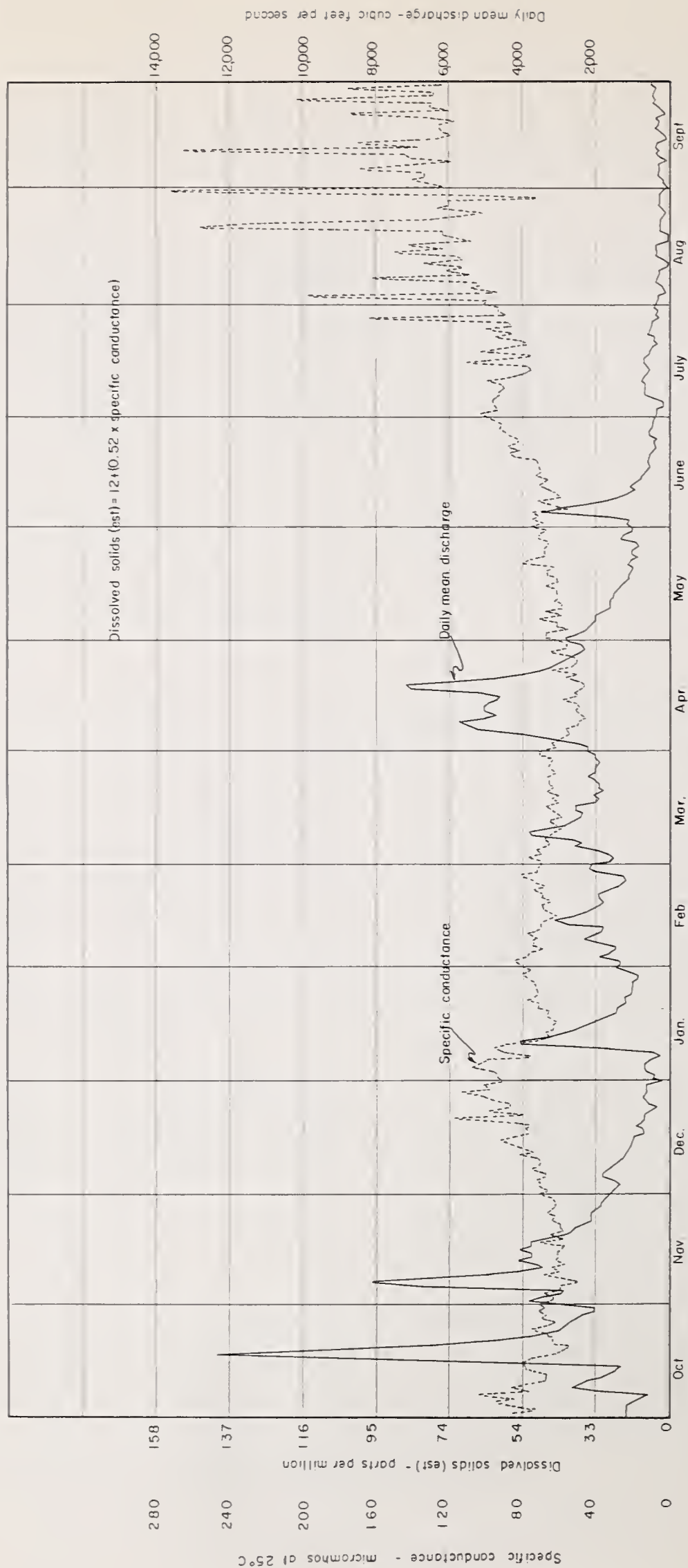


Figure 16.- Specific conductance and daily mean discharge, Quinebaug River at Jewett City, 1955-56

No comparison of the chemical quality is being made of the Quinebaug River at Putnam and at Jewett City. At the latter point the drainage area is about twice that at Putnam. Then, too, the available record is for the period 1955-1956; a period marked by hurricane floods and generally high flows. Under these conditions, the range in concentrations of dissolved solids was 37 - 82 ppm, and the range of hardness 14 - 44 ppm.

Irrespective of the sampling period, the chemical composition of waters from all streams in the Thames River basin consisted principally of sodium, calcium, bicarbonate, and sulfate. Generally, the concentrations of sodium and calcium were approximately the same. At Putnam, the concentrations of sodium were slightly greater than those for calcium except during periods of low flow, when streamflow was sustained principally by ground water inflow. At such times, the concentrations of sodium were 2 - 3 times greater than those for calcium.

Stream pollution is not entirely excluded as a probable cause for the differences in concentrations of sodium and calcium. However, if stream pollution were intermittent it is believed that the sodium - calcium relationship would be erratic. On the other hand if pollutants were continually discharged into the stream, the ratio of sodium to calcium would be approximately the same irrespective of flow.

A possible explanation may lie in the mineralogy of the deposits drained by the Quinebaug and its tributaries upstream from Putnam. Drainage during high flow consists principally of surface runoff in contact with the sand and gravel deposits. Mineralogically, these deposits may contain approximately equivalent quantities of sodium and calcium. Ground water is also a component of streams at high flow but to a lesser extent than surface runoff. During low flow, the ground-water portion is greater and at times is the only contributing source of streamflow. Drainage may be from the cracks and fissures in the bedrock plus the unconsolidated deposits and material weathered from the base rock. If the deposits are rich in sodium such as the mineral albite and to a lesser extent plagioclase (which consists of both sodium and calcium silicates) a higher ratio of sodium to calcium in solution would be expected. This explanation is only a tentative hypothesis which can only be verified

by further investigation, especially mineralogical analyses.

Concentrations of iron as high as 0.93 ppm have been determined in surface water in the basin (fig. 17 & 18). The concentrations of iron varied with streamflow and were highest during low flow. Iron oxide is an important cementing agent in unconsolidated deposits in the eastern part of the state. Because of the availability of a source of supply, iron is always present in water.

Summary

Surface waters in the Thames River basin drain an area that consists of crystalline rock overlain with sand and gravel, and till. Because of the relatively low solubility of these deposits, only moderate quantities of mineral matter are dissolved. This condition is reflected in the chemical quality of surface waters in the basin with moderate quantities of dissolved solids and very low hardness (table 14). The chemical composition of the surface waters consists principally of sodium, calcium, bicarbonate and sulfate and lesser quantities of other constituents naturally found in surface waters. Iron concentrations, though lower than those of the above constituents, are an important consideration insofar as the utility of these waters is concerned. Many streams show some evidence of pollution but the direct contribution to the mineral content of the streams is not known. At present, no data are available on the chemical quality of ground water in the area. This situation will be remedied as the investigation of chemical quality of water resources in the state progresses.

TEMPERATURE

Surface Water

Temperature of surface water usually fluctuates in a cyclic pattern that follows seasonal changes. Shallow streams in particular will follow changes in air temperature closely. In contrast, deep rivers follow changes in air temperature more slowly and thermal gradients are often established from surface to bottom. This cyclic seasonal pattern, however, may be

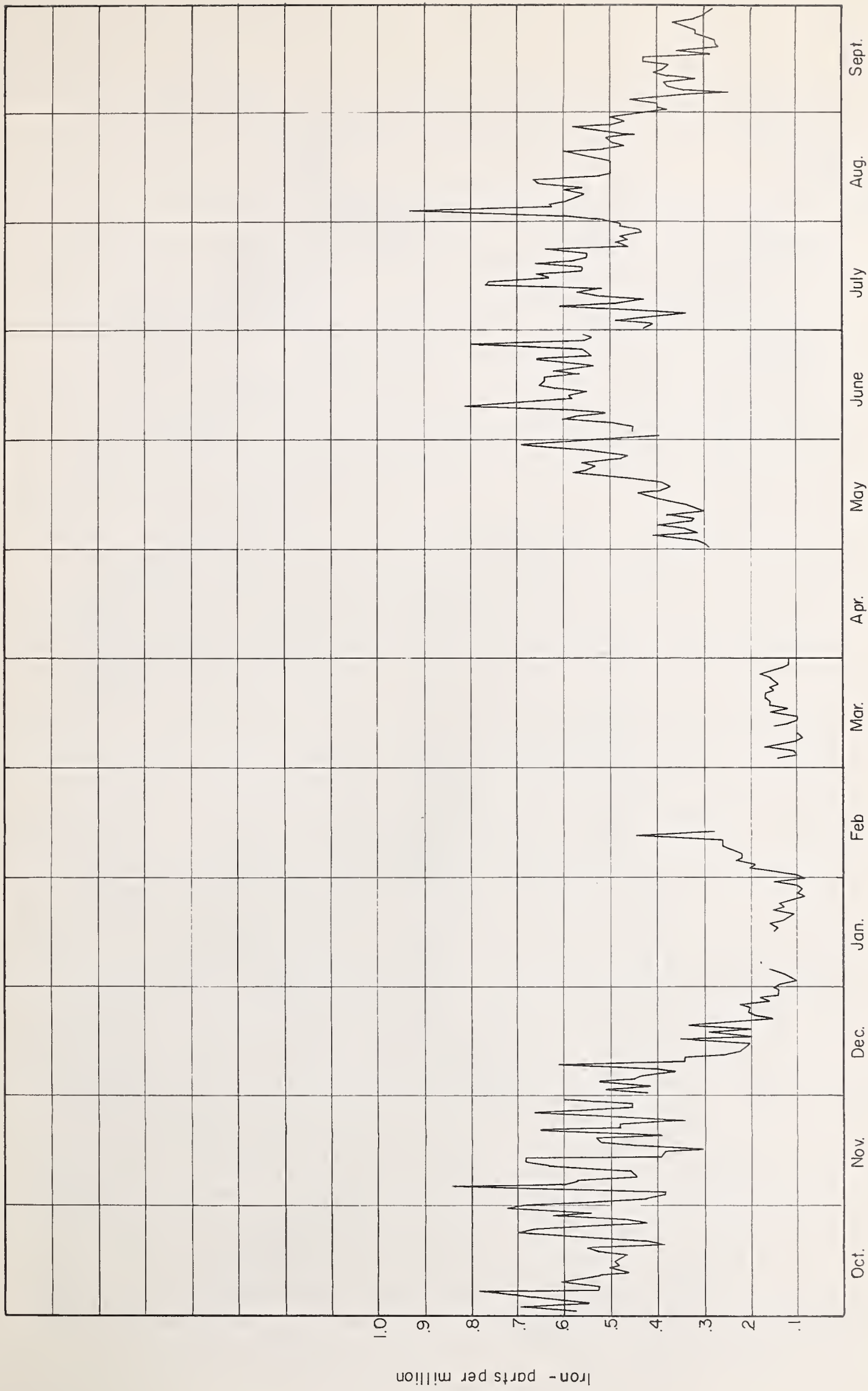


Figure 17 - Daily iron concentrations, Quinebaug River at Putnam, 1957 - 58

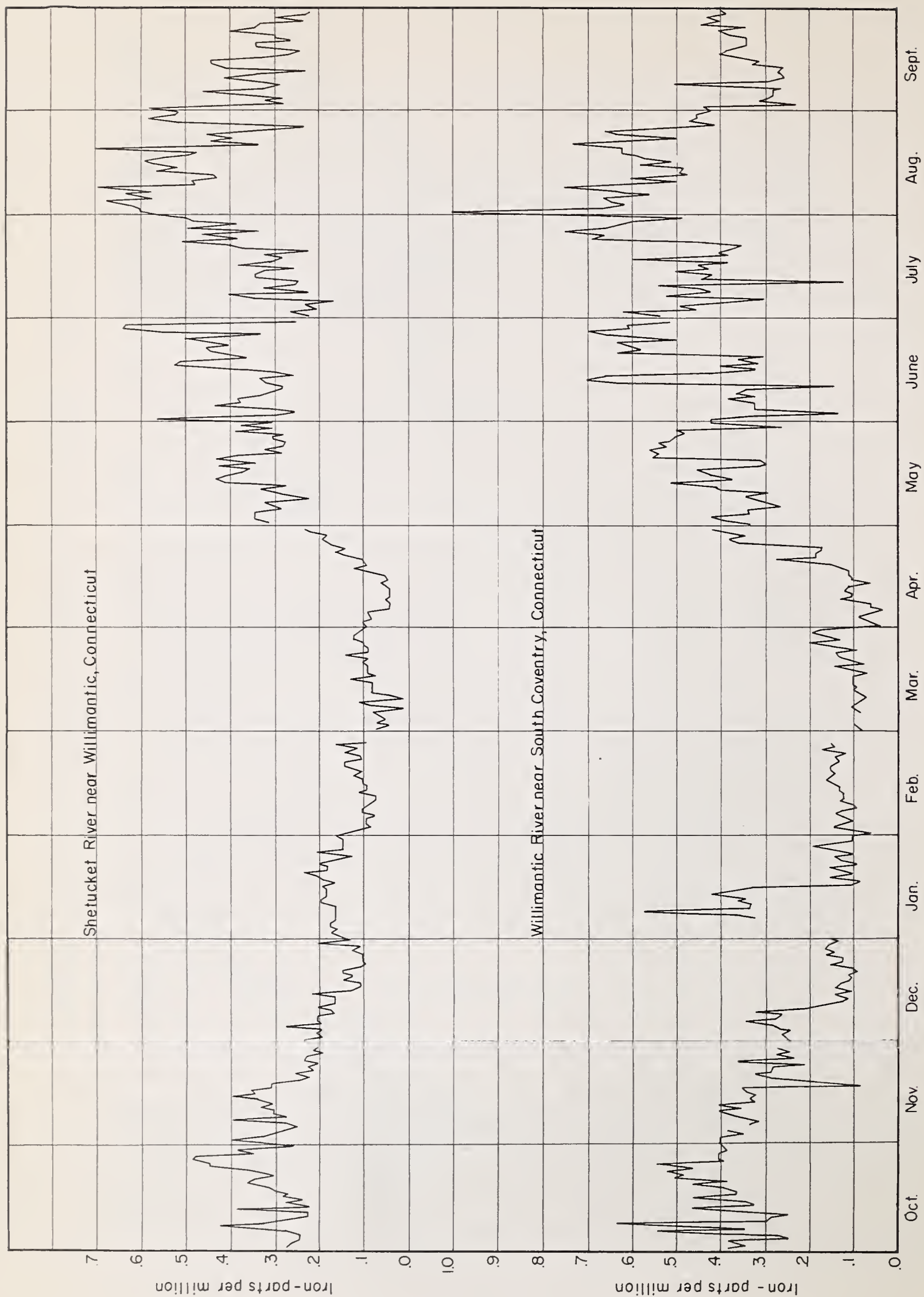


Figure 18.- Daily iron concentrations, Shetucket River near Willimantic, and Willimantic River near South Coventry, 1956 - 57

modified by inflow of industrial wastes and domestic sewage into a stream. It may also be slightly displaced from year to year depending on the variations in climate.

Temperature influences many of the chemical and physical processes that take place in a stream. The solubility of gases and of mineral matter is related to temperature. Oxidation of organic matter is promoted or retarded with changes in temperature. Algae and bacterial growth are similarly affected. Such hydrologic properties as density and viscosity vary with temperature. In the disposal of liquid wastes into a stream, differences of temperature between two liquids (among other factors) will determine depth of stratification and length of time to reach thermal equilibrium. Viscosity will affect the settling rate of suspended sediment.

In addition to the effects mentioned, temperature of water has a bearing on its utility. Water is an excellent heat-exchange medium and is used extensively for cooling purposes. Temperature of water is an indirect measure of the capacity of water to absorb heat energy and is a measure of its utility for cooling purposes.

Temperature of surface waters in Connecticut follow a seasonal pattern, decreasing erratically late in October, hovering near freezing during the winter months, and gradually rising in April. Ninety five percent of the time water temperatures in major streams in Connecticut equalled or were less than about 80 degrees Fahrenheit (table 16). The maximum temperature shown in figure 19 occurred during the summer months.

The cyclic seasonal pattern of water temperature is apparent for all streams, but the trend, if any, cannot be predicted because of the short period of record; one year for most streams and 3 years for the Housatonic River at Falls Village. For the Scantic River at Broad Brook, 5 years of record are available but no trend is apparent (fig. 20).

Table 16. --PERCENT OF TIME WATER TEMPERATURE ($^{\circ}$ F)
EQUALLED OR EXCEEDED TEMPERATURE SHOWN

Stream and Location	Period	Percent						
		5	10	25	50	75	100	
Connecticut River at Thompsonville, Conn.	1955-56	79	77	70	49	38	32	
Farmington River at Rainbow, Conn.	1957-58	77	76	71	55	40	32	
Housatonic River at Falls Village, Conn.	1955-58	75	73	66	48	35	32	
Naugatuck River near Thomaston, Conn.	1957-58	78	76	68	53	38	32	
Quinebaug River at Jewett City, Conn.	1955-56	74	73	68	50	37	32	
Quinebaug River at Putnam, Conn.	1957-58	77	75	68	56	43	32	
Quinnipiac River at Wallingford, Conn.	1956-57	79	76	72	55	41	32	
Scantic River at Broad Brook, Conn.	1953-58	76	74	67	54	39	32	
Shetucket River at Willimantic, Conn.	1956-57	78	76	71	55	39	32	
Willimantic River near S. Coventry, Conn.	1956-57	73	71	67	53	40	32	

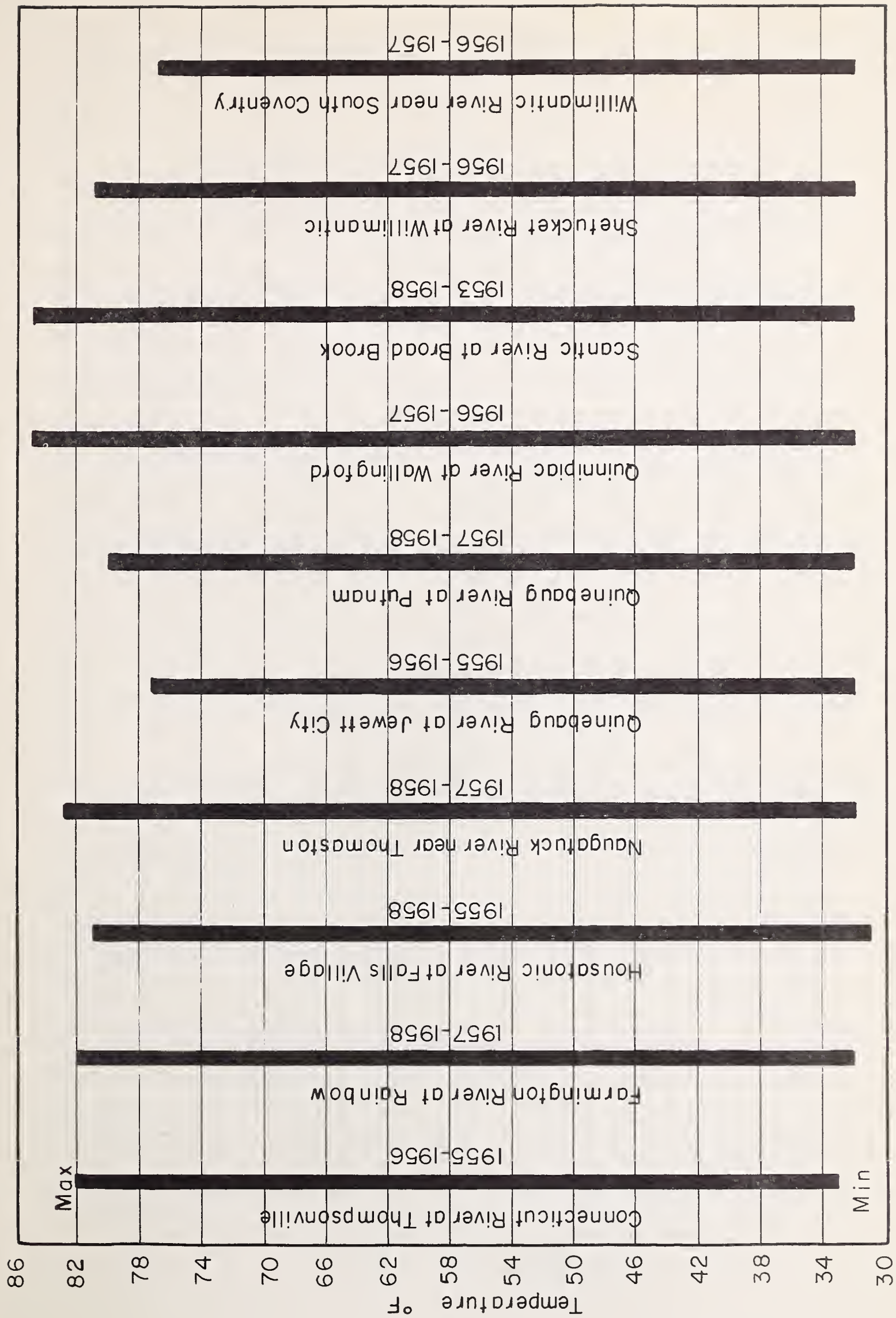


Figure 19 - Maximum and minimum water temperatures of selected rivers in Connecticut

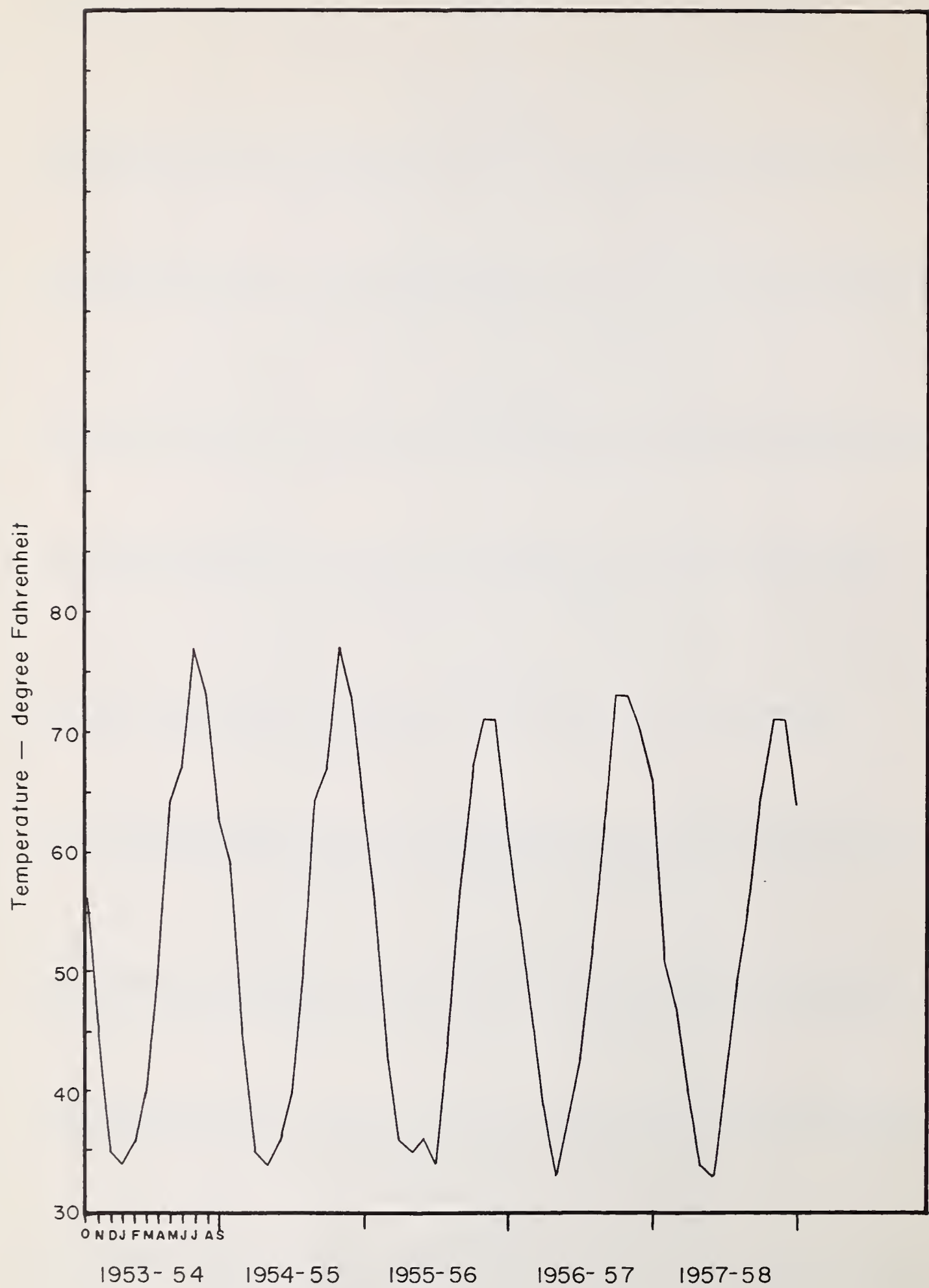


Figure20.- Monthly mean water temperature, Scantic River at Broad Brook, 1953 - 58

Ground Water

Temperature of ground water is essentially uniform in contrast to the cyclic pattern and wide seasonal fluctuations of surface water. However, some change in temperature is observed in shallow wells due to fluctuation in air temperature (wells Afl and Sbl, table 17). But at greater depths the effect of air temperature is less apparent. For example, the temperature of water in well F7 fluctuated only 3 degrees (50 - 53 F) during 1957-59 irrespective of air temperature (table 17). Because of its rather uniform temperature, ground water is used extensively for cooling purposes.

In Connecticut, measurements of water temperature are made at nine observation wells. Data obtained from three of these wells are shown in table 17. These are representative of water temperatures in shallow wells in unconsolidated material and deeper wells in bedrock.

SUSPENDED SEDIMENT

Fluvial sediment is derived principally from soil particles eroded from the land surface and transported by surface runoff. The quantity eroded and transported will vary with land use, stage of land erosion, vegetal cover, intensity and duration of rainfall, and topography. The stream bed and banks are contributing sources of supply. Bank erosion may be severe. Deposited sediment can be suspended again, move in a series of hops, roll and slide along the bed depending on the density of the material and turbulence. The composition of the fluvial sediment - clay, silt and sand will vary with the availability and erodability of these materials in the drainage basins.

Fluvial sediment indicates or can cause many problems. Initially, fluvial sediment represents wastage of the land and indicates a soil-conservation problem. Sediment may be deposited in reservoirs, lakes or ponds and thereby decrease the capacity of these facilities. Sediment in a stream used as a source of water supply requires removal before the water can be

Table 17. --TEMPERATURE OF GROUND WATER IN OBSERVATION
WELLS IN CONNECTICUT BASED ON MONTHLY READINGS

Well No. Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct	Nov.	Dec.
Air and Water temperature in degrees Fahrenheit												
Afl 1957 Water	44	43	43	44	47	48	51	52	--	--	--	46
Air	32	28	53	59	75	74	79	79	--	--	--	37
1958 Water	44	42	41	43	45	47	48	55	54	52	50	44
Air	34	36	46	50	65	69	64	74	55	53	32	37
1959 Water	--	41	40	42	44	49	51	52	52	51	49	48
Air	--	39	32	45	79	88	81	79	78	53	37	32
Sbl 1957 Water	47	45	--	45	47	49	51	--	52	--	--	48
Air	34	34	--	77	75	81	94	--	78	--	--	37
1958 Water	48	--	45	45	45	49	51	52	53	52	49	47
Air	72	--	41	63	63	76	83	73	60	54	32	38
1959 Water	45	44	44	45	47	51	54	53	53	52	51	48
Air	41	41	40	61	86	86	85	82	76	48	34	33
F7 1957 Water	--	--	--	52	--	--	52	53	52	--	51	52
Air	--	--	--	67	--	--	64	73	56	--	36	24
1958 Water	51	52	52	--	--	52	--	52	52	51	--	51
Air	25	40	64	--	--	85	--	70	57	48	--	33
1959 Water	51	51	51	51	51	52	51	51	51	50	50	50
Air	26	49	47	55	69	--	--	78	74	50	--	--

Well Afl - Dug well in glacial till, diameter - 30 in., depth - 15 ft., located in Yale

University forest near Westford, Ashford township.

Well Sbl - Dug well in glacial sand and gravel, diameter - 24 in., depth - 18 ft., located near South Britain, Southbury township.

Well F7 - Drilled well in Triassic basalt, diameter - 6 in., depth - 101 ft., located in Farmington, Farmington township.

used (assuming it is satisfactory otherwise). Recreational use of streams is affected if they are heavily laden with sediment. In recent years, sediment has to be considered in conjunction with disposal of radioactive wastes as they are capable of adsorbing and transporting radioactivity in varying degrees.

This report will discuss only the sediment characteristics of Scantic River at Broad Brook where continuous determinations of sediment have been made since 1952. Other streams will be covered in subsequent reports as the investigation of quality of surface water progresses.

Scantic River meanders through a tobacco-growing area of gently rolling lowland. Elevations along the river are as high as 150 ft. above sea level. In places the width of the flood plain is about 0.2 mile and becomes narrower in the vicinity of Broad Brook. At this location, the drainage area is 98.4 square miles and consists principally of sandy soil mixed with some silt and clay.

The sediment discharge rate in the Scantic at Broad Brook is less than 10 tons per day about 50 percent of the time (table 18). However, with rising stage and increased stream discharge, sediment discharge increases rapidly for short periods (fig. 21).

The sediment load followed no particular pattern as to the time of year but increased concurrently with intense and prolonged rainfall. Generally, the sediment load was lowest during the summer months. During the hurricane floods in 1955, however, the maximum suspended load of 6,670 tons per day occurred on August 19. The total sediment load for the month of August was 12,115 tons of which 10,890 tons passed the Broad Brook station during August 19 and 20. This sediment load was 70 percent of the total load of 15,569 tons for the water year 1955. In October 1955, additional floods occurred. The monthly sediment load was 4,074 tons or 47 percent of the total annual load for water year 1956 (fig. 22).

Records of sediment discharge prior to 1952 are not available for comparison and the current record is insufficient

Table 18. --PERCENT OF TIME DAILY SEDIMENT LOAD
(TONS PER DAY) EQUALLED OR
EXCEEDED THOSE TABULATED,
SCANTIC RIVER AT BROAD BROOK

	Percent					
	5	10	25	50	75	99
1952-53	108	58	17	7	5	3
1953-54	23	13	8	7	5	2
1954-55	54	29	11	7	6	3
1955-56	75	35	12	6	4	3
1956-57	17	9	6	5	5	2
1957-58	46	25	9	4	3	2

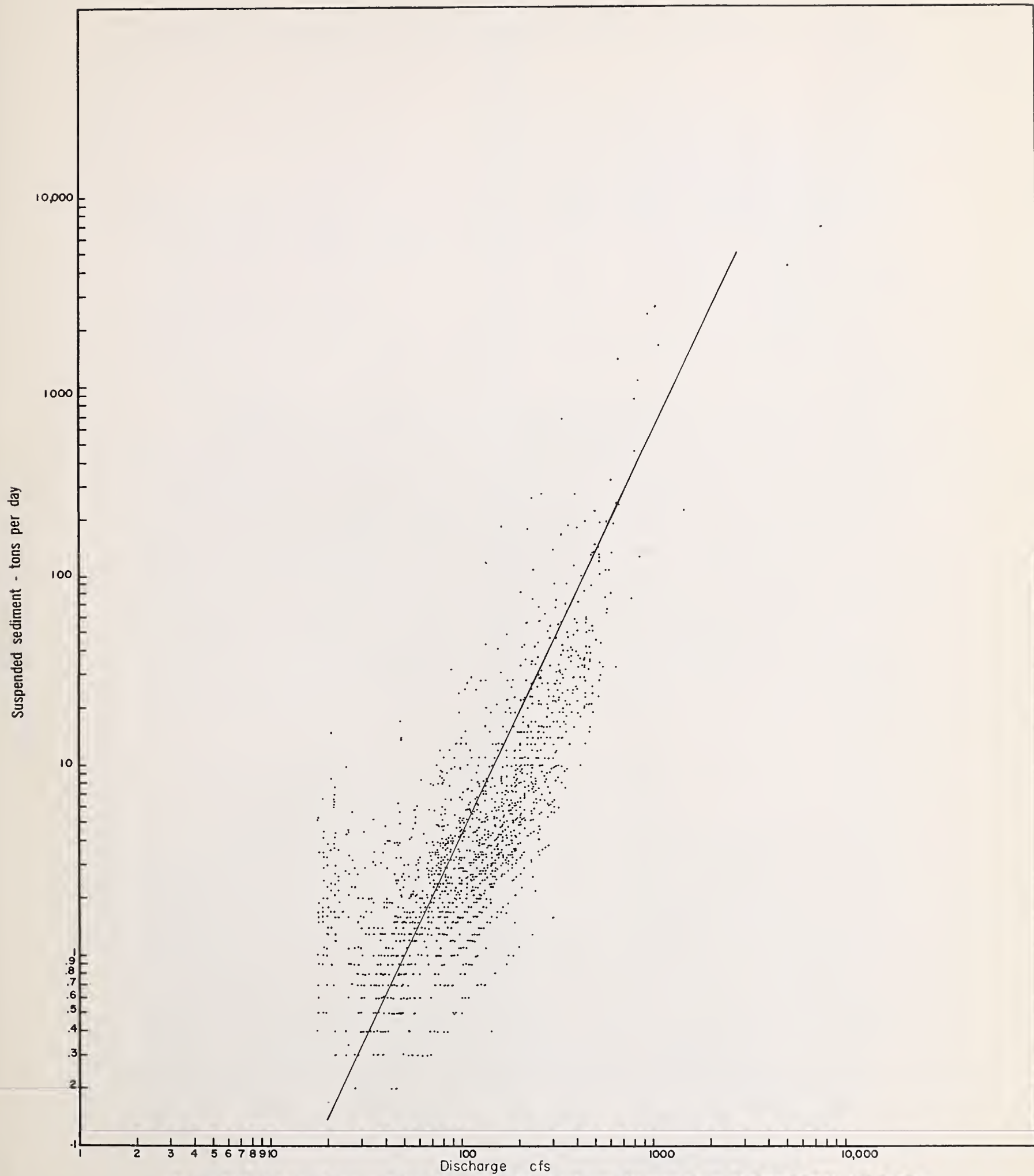


Figure 21-Relation of suspended sediment load to discharge, Scantic River at Broad Brook, 1954 -58

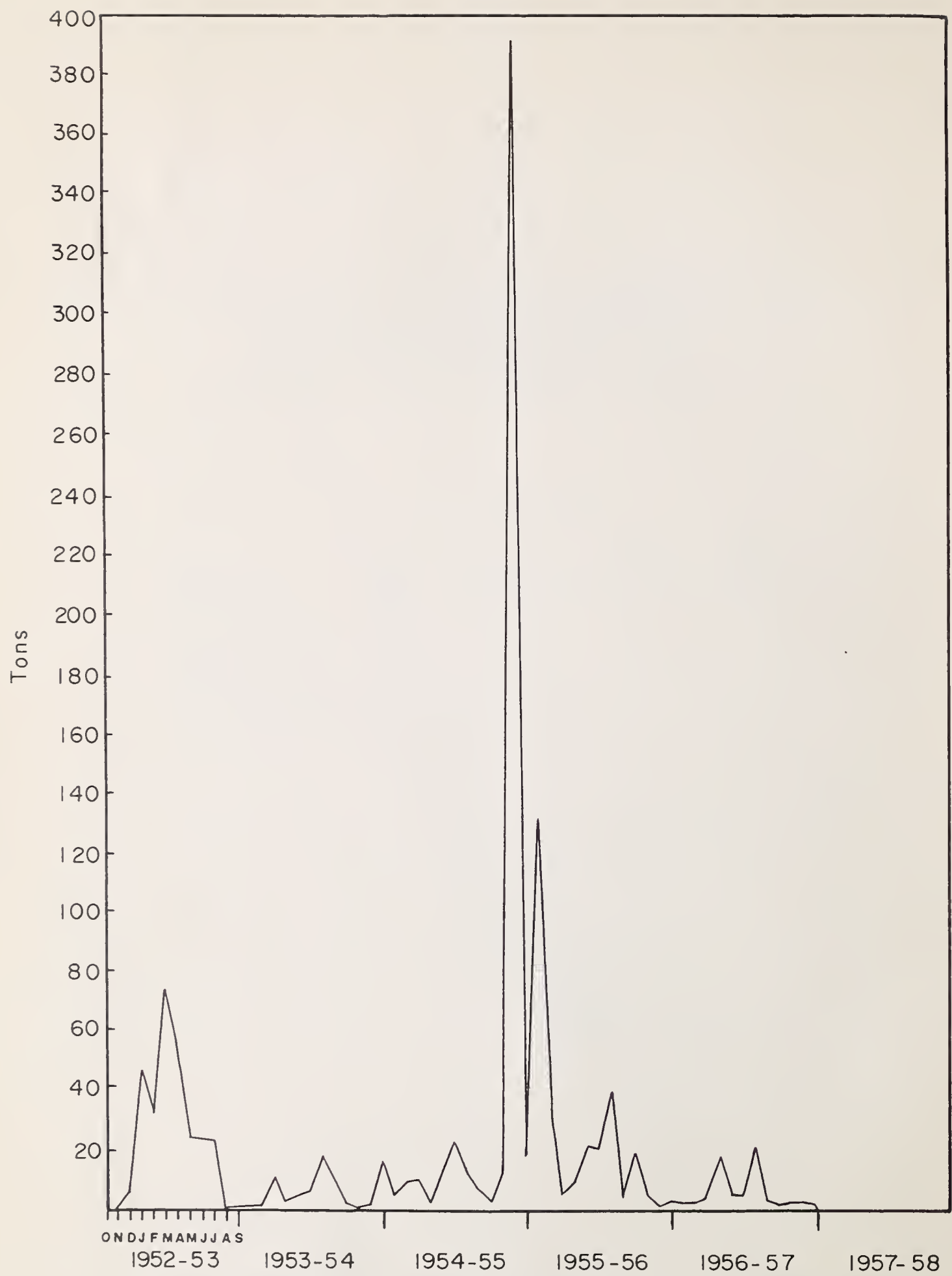


Figure 22: Monthly mean sediment load (tons), Scantic River at Broad Brook 1952 - 1958

to predict any trend. Total annual sediment discharges for the period of record are given below:

Water Year	Sediment Load		
	Tons per day		Tons
	Max.	Min.	Total for period
1953(Nov. 25, 1952 - Sept. 30, 1953)	708	0.2	7,471
1954	189	0.2	2,460
1955	6,670	0.2	15,569
1956	1,376	0.4	8,656
1957	185	0.2	2,124
1958	185	0.3	3,826

Usually the particle size of the suspended sediment in the Scantic River consisted of a very high percentage of silt and clay (as much as 96 percent) and lesser quantities of the sand sizes (table 19). This composition reflected the soil characteristics of the drainage basin--principally sandy loam and clay. However, the composition changed drastically during floods such as the hurricane floods of autumn 1955. As stream velocities increased erosion of the bed took place. The heavier particles of sand that had accumulated on the bed were again suspended and transported downstream. As much as 81 percent of the suspended sediment consisted of sand and the remainder was silt and clay.

WATER, QUALITY AND UTILITY

The utility of water is dependent in part on its quality. Hard water is objectionable for domestic and industrial purposes because excessive amounts of soap are consumed, precipitates are formed and scale is deposited. If concentrations of iron and manganese exceed 0.3 ppm, usually discoloration and deposition will take place. Acidity of water will promote corrosion in distribution systems. Excessive amounts of dissolved solids, alkalies, bicarbonate and chloride in water will render it unsuitable for irrigation. The importance of the quality of water is indicated by the fact that quality of water standards have been established for many uses such as industrial, agricultural and

CONNECTICUT RIVER BASIN

Table 19.--SCANTIC RIVER AT BROAD BROOK, CONN.

Particle size analyses of suspended sediment, water years October 1953 to September 1958

(Methods of analysis: B, bottom withdrawal tube; D, decantation; P, pipette; S, sieve; N, in native water;
W, in distilled water; C, chemically dispersed; M, mechanically dispersed)

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Date of collection	Time	Instantaneous discharge (cfs)	Water temperature (°F)	Suspended sediment _b													Methods of analysis
				Concentration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters											
						0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.350	0.500	1.000	
Aug. 31, 1954-----	6:30 p.m.	138	64	61	351	20	21	38	52	63	76	90	98		100	--	SBCWM
Sept. 1-----	6:30 p.m.	161	64	59	200	10	24	37	53	68	84	96	99		100	--	SBCWM
Sept. 13-----	9:55 a.m.	657	57	41	231	1	3	25	37	55	74	92	99		100	--	SBCWM
Aug. 13, 1955-----	4:30 p.m.	335	71	212	398	23	40	53	66	80	94	99	100		--	--	BCWM
Aug. 13-----	6:30 p.m.	365	71	154	321	20	25	36	47	63	95	99	100		--	--	BCWM
Aug. 14-----	6:30 a.m.	413	73	88	177	20	30	40	59	76	88	98	100		--	--	BCWM
Aug. 18-----	11:30 a.m.	260	76	369	665	35	50	61	78	87	96	100	--		--	--	BCWM
Aug. 18-----	2:30 p.m.	445	76	473	791	25	37	47	62	72	90	99	--		--	--	BCWM
Aug. 18-----	7:00 p.m.	768	76	273	422	25	36	49	64	74	90	99	100		--	--	BCWM
Aug. 20-----	11:50 a.m.	4,200	74	222	374	9	30	64	77	86	94	99	100		--	--	BCWM
Aug. 20-----	3:30 p.m.	3,280	74	154	294	39	57	74	87	92	94	99	100		--	--	BCWM
Oct. 15-----	--	--	60	690	1,800	2	4	7	14	25	42	79	99		100	--	SBCWM
Oct. 16-----	--	--	--	618	670	1	3	9	13	19	21	78	98		100	--	SBCWM
Oct. 16-----	--	--	--	940	1,890	1	2	4	7	14	34	70	100		--	--	SBCWM
Oct. 17-----	--	--	51	580	1,000	1	2	3	5	8	21	61	100		--	--	SBCWM
Oct. 17-----	--	--	51	186	350	1	1	4	5	10	19	52	99		--	--	SBCWM
Oct. 17-----	--	--	51	48	320	4	8	14	23	32	57	86	100		100	--	SBCWM
Oct. 18-----	--	--	--	96	200	2	5	6	12	18	31	60	100		--	--	SBCWM
Feb. 25, 1956-----	--	--	38	183	1,360	10	12	25	41	55	84	96	99		100	--	SBCWM
Feb. 26-----	--	--	35	122	659	18	19	30	43	71	88	91	93		99	100	SBCWM
Mar. 4-----	--	--	38	61	524	14	16	36	48	50	83	92	96		100	--	SBCWM
Mar. 7-----	--	--	37	199	2,060	13	16	34	47	61	80	92	99		100	--	SBCWM
Apr. 6-----	--	--	38	84	359	20	21	29	35	42	58	70	87		95	100	SBCWM
Jan. 23, 1957-----	--	--	36	191	2,070	10	22	37	54	68	85	96	99		100	--	SBCWM
Jan. 24-----	--	--	32	79	284	1	2	12	27	53	61	83	91		94	100	SBCWM
Mar. 16-----	--	--	46	31	137	29	40	57	69	79	82	97	100		--	--	SBCWM
Apr. 2-----	--	--	48	34	244	19	47	63	69	75	80	95	100		--	--	SBCWM
Apr. 5-----	--	--	42	68	478	20	24	36	49	61	73	94	99		100	--	SBCWM
Apr. 6-----	--	--	40	118	568	6	8	13	21	32	66	93	96		100	--	SBCWM
Apr. 17, 1958-----	--	--	--	120	764	23	34	50	65	78	91	95	98		99	100	BCWM
Apr. 18-----	--	--	--	22	95	9	18	48	74	85	89	91	95		99	100	BCWM

a Once daily temperature measurement

b Where no time and discharge is shown samples are composites and collected at different times on date shown

and domestic.

Process water used in foods, beverage and other industries must meet certain chemical quality standards. It must be free from tastes and odors. Other requirements are that it should be soft, clear, free from iron, manganese and low in dissolved solids. These and other suggested water-quality tolerances for some of the major industries are shown in table 20.

Water for irrigation is suitable if it contains moderate quantities of solutes and is relatively free of toxic substances. Small quantities of boron are necessary for plant growth but a concentration in excess of 1.0 ppm could be detrimental to sensitive plants. Concentration of dissolved solids is important although there is more latitude. For example, using specific conductance as a measure of dissolved solids, a water having a conductance of 2,000 micromhos per cm or less (approximately equivalent to a concentration of 1200 ppm) will have negligible effect on crops. As the specific conductance increases crops are affected and yields restricted. Shown below are class limits of specific conductance and crop response.

<u>Specific conductance</u> <u>(micromhos per cm</u> <u>at 25°C)</u>	<u>Crop response</u>
0 - 2000	Effects negligible.
2000 - 4000	Restricted yield of sensitive crops.
4000 - 8000	Yields of many crops restricted.
8000 - 16000	Only salt tolerant crops yield satisfactorily.
16000 +	Satisfactory yields from only a few very salt tolerant species.

The quality-of-water standards for domestic purposes are quite stringent insofar as chemical quality is concerned. In 1946, the U. S. Public Health Service established standards

Table 20. --SUGGESTED WATER-QUALITY TOLERANCES a/
(Allowable limits in parts per million)

Industry or use	Turbidity	Color	Hardness as CaCO ₃	Iron as Fe	Manganese as Mn	Total solids	Alkalinity as CaCO ₃	Odor Taste	Hydrogen sulfide	Other requirements b/
Air conditioning	--	--	--	<u>c/</u> 0.5	0.5	--	--	low	1	No corrosiveness, slime formation
Baking	10	10	--	<u>c/</u> .2	.2	--	--	low	.2	P.
Brewing:										
Light beer	10	--	--	<u>c/</u> .1	.1	500	75	low	.2	P. NaCl less than 275 p. p. m. (pH 6.5-7.0).
Dark beer	10	--	--	<u>c/</u> .1	.1	1,000	150	low	.2	P. NaCl less than 275 p. p. m. (pH 7.0 or more)
Canning:										
Legumes	10	--	25-75	<u>c/</u> .2	.2	--	--	low	1	P.
General	10	--	--	<u>c/</u> .2	.2	--	--	low	1	P.
Carbonated beverages	2	10	250	<u>c/</u> .2	.2	850	50-100	low	.2	P. Organic color plus oxygen consumed less than 10 p. p. m.
Confectionery	--	--	--	<u>c/</u> .2	.2	100	--	low	.2	P. pH above 7.0 for hard candy
Cooling	50	--	50	<u>c/</u> .5	.5	--	--	--	5	No corrosiveness, slime formation
Food: General	10	--	--	<u>c/</u> .2	.2	--	--	low	--	P.
Ice	5	5	--	<u>c/</u> .2	.2	--	--	low	--	P. SiO ₂ less than 10 p. p. m.
Laundrying	--	--	50	<u>c/</u> .2	.2	--	--	--	--	
Plastics, clear, uncolored	2	2	--	<u>c/</u> .02	.02	200	--	--	--	
Paper and pulp:										
Groundwood	50	20	180	<u>c/</u> 1.0	.5	--	--	--	--	No grit, corrosiveness
Kraft pulp	25	15	100	<u>c/</u> .2	.1	300	--	--	--	
Soda and sulfite	15	10	100	<u>c/</u> .1	.05	200	--	--	--	
High-grade light papers	5	5	50	<u>c/</u> .1	.05	200	--	--	--	
Rayon(viscose):										
Pulp production	5	5	8	<u>c/</u> .05	.03	100	total 50; hydroxide 8	--	--	Al ₂ O ₃ less than 8 p. p. m. SiO ₂ less than 25 p. p. m. Cu less than 5 p. p. m.
Manufacture	.3	--	55	.0	.0	--	--	--	--	pH 7.8 to 8.3
Tanning	20	10-100	50-135	<u>c/</u> .2	.2	--	total 135; hydroxide 8	--	--	
Textiles:										
General	5	20	--	.25	.25	--	--	--	--	
Dyeing	5	5-20	--	<u>c/</u> .25	.25	200	--	--	--	Constant composition
Wool scouring	--	70	--	<u>c/</u> 1.0	1.0	--	--	--	--	Residual alumina less than 0.5 p. p. m.
Cotton bandage	5	5	--	<u>c/</u> .2	.2	--	--	low	--	

a/ Moore, E. W., Progress report of the committee on quality tolerances of water for industrial uses: Jour. New England Water Works Assoc., vol. 54, p. 271, 1940.

b/ P indicates that potable water, conforming to U. S. P. H. S. standards, is necessary.

c/ Limit given applies to both iron alone and the sum of iron and manganese.

for drinking water which apply to water supplies of interstate carriers. These standards are generally accepted for public water supplies.

Mandatory limits (ppm)		Non-mandatory limits (ppm)	
Lead	0.1	Copper	3.0
Fluoride	1.5	Iron and Manganese	.3
Arsenic	.05	Magnesium	125
Selenium	.05	Zinc	15
Chromium (hexavalent)	.05	Chloride	250
		Sulfate	250
		Phenolic compounds	.001
		Total solids	500
		Permitted	1000

From the wide range of requirements, it is apparent that the chemical quality of most surface and ground waters in the state is satisfactory for multiple uses but is not necessarily satisfactory for all uses. In the western part of the state some surface and ground waters are moderately hard. In contrast, water sources in the central and eastern sections of the state generally have lower concentrations of dissolved solids and are soft. Iron might be a problem. Fortunately, with suitable treatment the chemical quality of raw water from most sources can be improved to meet the users requirements. In the use of water resources for public supplies, the sanitary quality is highly important. No attempt is made herein to evaluate the sanitary quality of water in the state. This is determined by the appropriate health agencies.

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APPENDIX

GLOSSARY

Bed material. - Sediment deposited on the surface of a stream bed.

Carbonate hardness. - Hardness of water due to calcium and magnesium equivalent to the bicarbonate and/or carbonate present.

Clay. - Sediment particles smaller than 0.004 millimeters.

Composite sample. - A mixture of two or more water samples collected at different times (usually daily) at the same location.

Cubic foot per second (cfs). - The rate of discharge of a stream whose channel is one square foot in cross-sectional area and whose average velocity is one foot per second.

Dissolved solids. - Residue from a clear sample of water after evaporation and drying of residue for one hour at 180°C.

Equivalent per million (epm). - Number expressing a weight ratio of parts per million of a substance to its equivalent weight. Equivalent weight is the atomic weight per unit valence. An equivalent weight of one substance will react or combine with an equivalent weight of another.

Fluvial sediment or sediment. - Fragmental material transported by, suspended in, or deposited by water.

Hardness. - The chemical and physical effect of calcium, magnesium and other cations having soap consuming and incrusting properties. In this report it is expressed as the calcium carbonate (CaCO_3) equivalent.

Noncarbonate hardness. - Hardness due to salts of calcium and magnesium other than those of bicarbonate and carbonate.

Part per million (ppm). - A unit of weight of a constituent in a million unit weights of water.

Sand. - Sediment particles having diameters between 0.062 and 2.000 millimeters.

Sediment. - Is fragmental material, suspended in or deposited by water or air or accumulated in beds by other natural agents.

Sediment concentration. - Ratio of weight of sediment in a water-sediment mixture to the total weight of the mixture. In this report, sediment concentration is expressed in parts per million (ppm).

Sediment load. - Weight of sediment transported per unit of time.

Silt. - Sediment particles having diameters between 0.004 and 0.062 millimeters.

GLOSSARY (continued)

Size analysis. - Definition of particle-size distribution in percent of total weight according to median size diameters in millimeters.

Solute. - A dissolved substance.

Specific conductance. - Conductance of an electric current per unit cross sectional area of solution and expressed in reciprocal ohms $\times 10^6$ (micromhos at 25°C).

Suspended sediment. - Sediment which is maintained in suspension in water for a considerable period of time without contact with the bed by the upward components of turbulent currents or by colloidal suspension.

Water year. - A period that begins October 1 of one year and ends September 30 the following year.

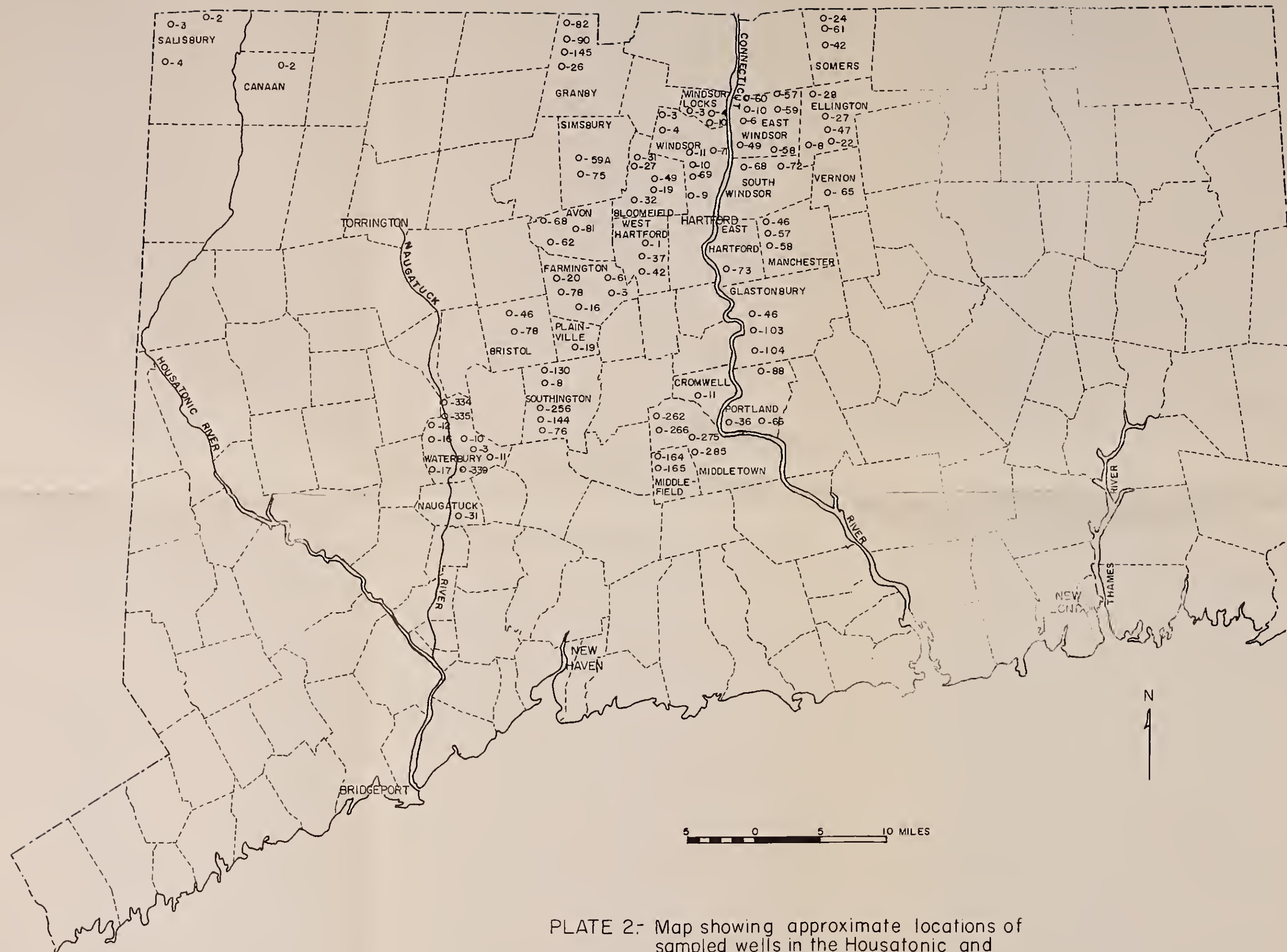




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Example:
To find well EW49. EW is an abbreviation for East Windsor town (see alphabetical listing below). Locote town on map; well symbol o and number 49 give approximate location of well EW49.

Abbreviation	Name of town
A	Avon
Bl	Bloomfield
Bs	Bristol
Cn	Canaan
Cr	Cromwell
EH	East Hartford
EI	Ellington
EW	East Windsor
F	Farmington
Gl	Glastonbury
Gr	Granby
M	Manchester
Mf	Middlefield
Mt	Middletown
Na	Naugatuck
P	Portland
Pv	Plainville
S	Southington
Si	Simsbury
So	Somers
SW	South Windsor
Sy	Salisbury
V	Vernon
W	Windsor
Wb	Waterbury
WL	Windsor Locks

PLATE 2: Map showing approximate locations of sampled wells in the Housatonic and Connecticut River Basins.

MASSACHUSETTS



PLATE I Map of Connecticut showing the following river basins :
A. Housatonic River, B. Connecticut River, C. Thames River
and D. Quinnipiac River

